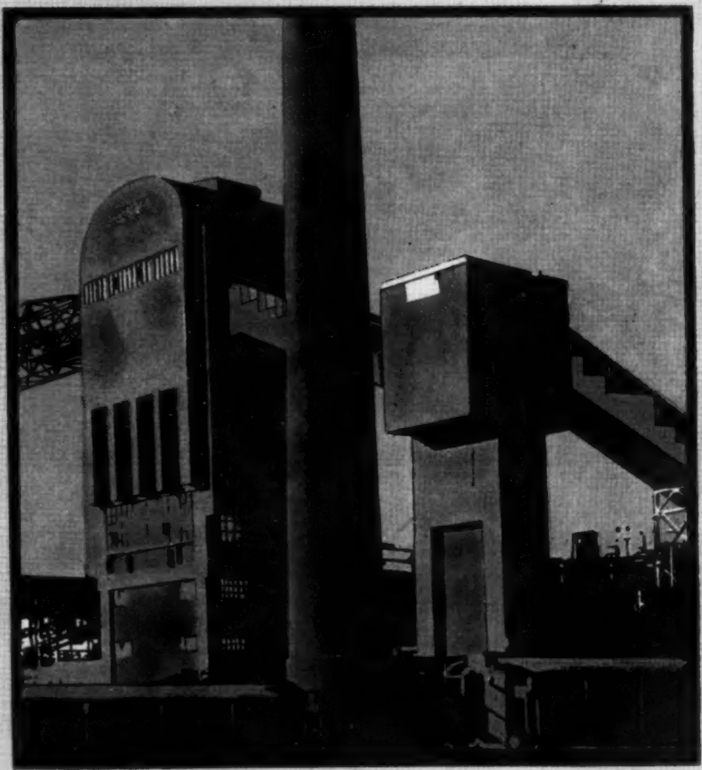
THE ARCHITECTURAL FORUM

IN TWO PARTS



PART ONE

ARCHITECTURAL DESIGN

SEPTEMBER

1929

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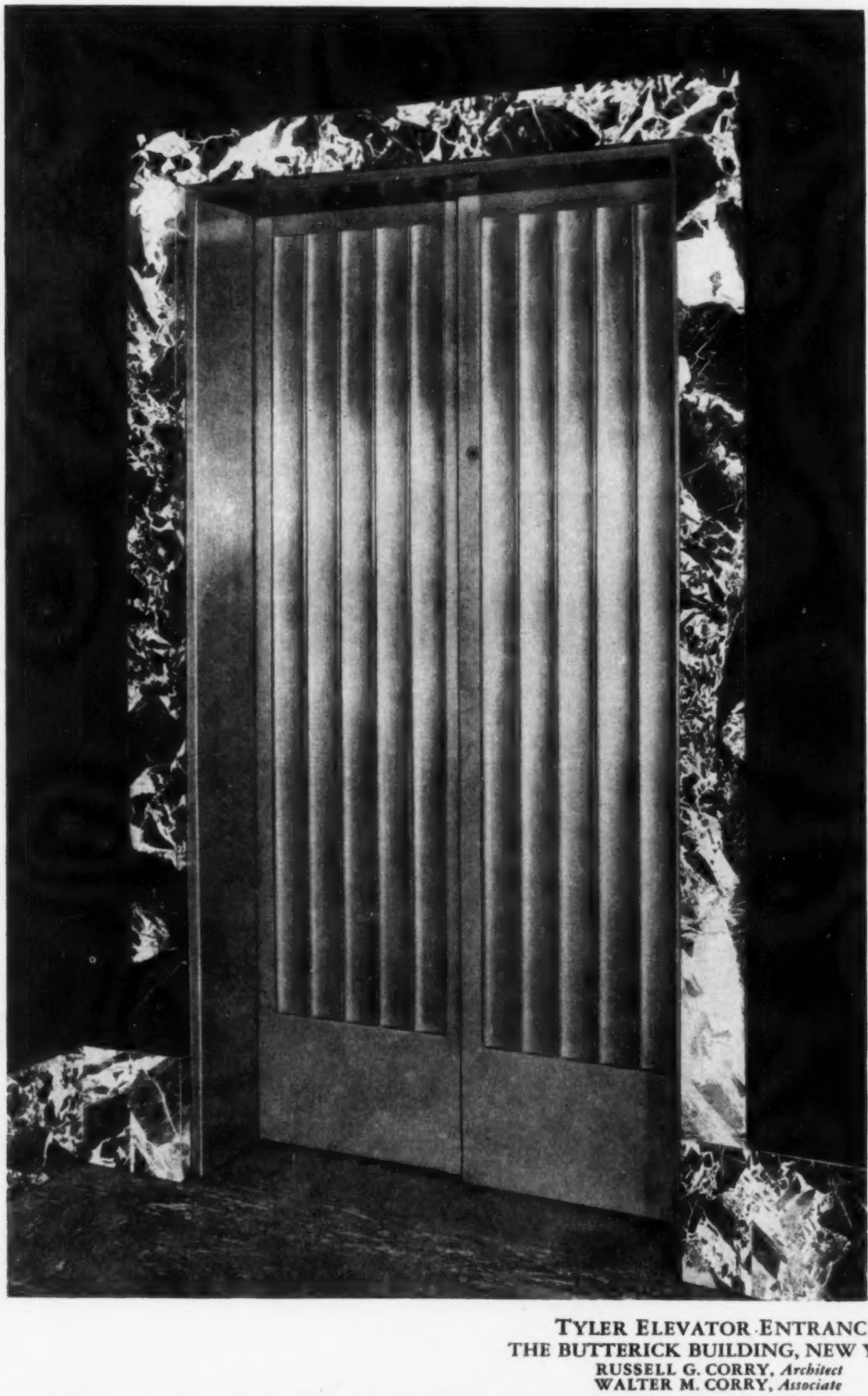

TYLER ELEVATOR ENTRANCE
THE BUTTERICK BUILDING, NEW YORK
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BOOK DEPARTMENT

MINOR ARCHITECTURE OF SUFFOLK

A REVIEW BY
ROBERT STUYVESANT HOOKER

Of all England no district is richer in historic tradition, natural scenic beauty, and good architectural precedent than Suffolk. Since the time that William the Conqueror became king and divided Suffolk into 629 manors and apportioned them among his followers, Suffolk has been the scene of great political and industrial activity. It has suffered at the hands of intriguing barons and has been the home of many of the great public characters of English history, and of countless home-loving country squires, farmers and peasants whose homes ranged from the simplest cottage to the most imposing of castles, many of which are still existing.

The Norman conquerors upon coming into possession of the land immediately started building themselves great castles including those at Bungay, Clare, Eye, Framlingham and Haughley. At the same time an astounding number of monastic buildings were being erected in the district, including Gilbert Blount's priory at Ixworth in 1100; Ralph Fitz Brian's priory at Great Bricett in 1110; the monastery of Hubert de Montchensey at Edwardstone in 1114; the convent at Redlingfield in 1120, and many other such buildings. But there was much internal strife between the barons and kings, and the people were mistreated and plundered so that the period was productive of great fortress-like castles which were the prey of all invaders and therefore were thrown down and destroyed in so many instances that today we scarcely have an idea of what they were like. On the other hand, the poverty stricken condition of the population did not lend itself to the development of an important growth of domestic architecture. Domestic building flourished at a later date, after Suffolk had become commercially prominent, largely through the introduction of the woolen industry in 1336. This industry, introduced by the Flemings and vigorously followed by the natives, was in a great measure responsible for the exceptional prosperity enjoyed by Suffolk over a long period of time. Although comparatively few Flemish people settled in Suffolk, there is a marked Flemish influence in the architecture of the period. The prosperous people built themselves comfortable cottages, and the squires and merchants erected great halls and country estates which include some of the best examples of English architecture. Of these great halls and manor houses many remain today as homes of the wealthy; others have fallen from their lofty estate and serve as farmhouses,

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while still others have fallen to ruin and have disappeared. The cottages themselves have also suffered the ravages resulting from the march of progress, and as is the case in America, fine old structures are ruthlessly torn down to make room for ugly buildings of a more up-to-date type. In a great majority of cases the charm of English cottage and farmhouse architecture lies in its severe simplicity, the work of construction having been done in most instances by local craftsmen using local, or easily transported materials, such as brick and timber, which resulted in the interesting and ever popular half-timbered type of building so characteristic of English architecture. The half-timber work found in Suffolk is perhaps more pleasing than that of any other district of England in that it seems to possess a solid, honest quality often lacking in the houses of other districts. Another feature of the Suffolk buildings is the great variety in the color of the brick which, though not always pleasing, in a great majority of cases lends added charm to the work. It is in this brick work that the Dutch, Flemish and Huguenot influence is most strongly felt, and there are many buildings in Suffolk with very decidedly foreign lines which serve to heighten the variety and interest of the general architectural effect.

As is to be expected in a country so rich in architectural precedent, eagerly sought by the modern architects of two continents as inspiration for their own designs, the English countryside and cities have been combed and recombed, and photographed and sketched from every angle. There is a tendency, however, for the busy architect or student who has limited time for travel and wishes to cover during that period the greatest possible extent of territory, to keep to the beaten paths and easily accessible landmarks. Indeed for one to cover in anything like a complete manner the whole of the English countryside, it might well be necessary to spend a lifetime. It is in the cities and more frequented places that the greatest destruction due to modernization has taken place. However there are still numerous forgotten little villages hidden away along the byways and among the fields where the hand of progress has rested lightly, and where one may still find "Old England" unspoiled. Such a search, however, requires infinite patience and unlimited time not in the realm of possibility for most of us, so that we must be content with collections of illustrations and descriptions by those who have had the opportunity of making a special study and investigation of the subject, and already several such works have appeared.

Such a collection on the subject of English architecture is being prepared to cover the entire field in as complete a manner as possible, presenting photographically the domestic architecture of old England in two main divisions,—one on the major architecture, including castles and mansions, and the other devoted to minor architecture such as manor houses, cottages and farm houses. The material will be grouped as far as is possible by counties, depending on the amount of material available as to whether one or more counties shall be dealt with in one volume. In the case of Suffolk it was found that there existed such a wealth of material that in the preparation of the volume entitled, "The Minor Architecture of Suffolk" it was possible to include only a part of the illustrations available. This of course permits of a greater selectivity, so that only the best of a

large number of examples appear in its pages. The work is edited by Dexter Morand and is made up almost entirely of full-page plate illustrations in collotype from original photographs made especially for this volume. The introductory text matter gives a brief description and discussion of the architectural character of the Suffolk countryside and the conditions under which its development took place. There is also a short monograph on the manner of seeking out secluded places and locating the best examples of work typical of the old English styles. The historical notes are quite complete and have been carefully compiled by investigation of a great quantity of source material. They deal with all the events of English history occurring in Suffolk from the time of William the Conqueror down to the reign of Queen Mary. These events are presented in such a way that their bearing on the architectural development of the country is made evident, and the reader is given a historical background against which to view the architectural subjects which follow.

As is always the case in a work of this character, it is the plates in which architects are principally interested, and in this instance they are well worth careful study. A brief description of a few chosen at random will perhaps help in giving an idea as to the nature of the subjects shown. At Aldeburgh, Moot Hall is an unusual combination of half-timber, stucco and brick. The beauty of the general proportions is perhaps marred by the towering chimney with its two octagonal pots. However, the detail of this chimney is so interesting that as a source for precedent it offers great possibilities. At Bildeston a small cottage with its entry opening directly onto the street presents an interesting arrangement of windows, and the overhanging second story with timber brackets relieving the blankness of the white stucco facade affords many suggestions. Two other roadside cottages of Bildeston, with shop windows on the first floor and projecting upper stories, are also shown. A half-timbered cottage at Chelsworth is placed end-on to the street and flanked by a low brick wall with white picketed gate. The heavy thatched roof adds a touch of ruggedness. At East Bergholt, the Bell Cage is notable chiefly for the shape of its roof which suggests an interesting way of terminating a long, narrow cottage roof. Three photographs taken at Flatford showing the Valley Farm, Constable's Mill, and a heavily thatched cottage by the side of the stream are more interesting for the scenic beauty of the settings than as architectural material. The treatment of the brick filling in the half-timber of one side of the Fox and Goose Inn at Fressingfield presents an interesting variety of patterns, and the general proportions of the structure are very satisfying. Hadleigh with its interesting Guild Hall and many cozy little shops offers a wealth of material, and the several illustrations here shown are well chosen for the purposes of the architect. From Hintlesham we have a snug little white walled cottage nestling behind its hedges and white picket fence, and a larger half-timber building of the manor house type. Ipswich was at one period among the most prosperous cities of England, and "Ye Olde Neptune Inne" and numerous other shops and buildings offer a wealth of detail and interesting material. The author of this work refers to Kersey as "as charming and unspoilt a village as exists in England, without visiting which no architectural pilgrimage in

Suffolk would be complete." Indeed the scenes here shown would make excellent stage settings for a Shakespearean drama. Some primitive wood carving over a shop front at Halesworth furnishes the subject for excellent detail, and a massive wrought iron studded door from Kersey is a marvel in sturdiness. The Lavenham Guild Hall is unusually interesting and rich in detail, though the half-timber work would very likely become extremely monotonous were it not for the numerous leaded glass windows and the carved detail of the beam at the projection of the upper story. The corner posts of the building are also richly carved, and a close-up view presents the detail quite distinctly. The Wood Hall and other buildings at Lavenham are rich in half-timber work and interesting arrangement of parts. Although the front facade of the Bull Inn seems a slightly jarring note among so much architectural perfection, its courtyard is charming and reminiscent of other days. One of the most pleasing bits of domestic architecture is shown from Monks Eleigh. This is a severely simple little cottage with thatched roof and plaster walls. Much of the credit for the effect of this illustration may be due to the setting, but the general effect is extremely beautiful and satisfying. The shops and cottages of Woodbridge contain a great deal of good half-timber arrangement and are characterized by the informal spacing and placing of windows and doors, which is responsible for much of the charm in old English architecture.

MINOR ARCHITECTURE OF SUFFOLK. Series One. By Dexter Morand. Text and 48 Plates, 9 x 12½ ins. Price 17 s 6 d. John Tiranti & Co., 13 Maple Street, Tottenham Court Road, London. (Orders to be sent directly to publisher.)

STRENGTH OF MATERIALS. By Jasper Owen Draffin. 275 pp., 6 x 9 ins. Price $3. John Wiley & Sons, Inc., 440 Fourth Avenue, New York.

THE author of this valuable work is Assistant Professor of Theoretical and Applied Mechanics at the University of Illinois. "The book was written as a result of an effort to find a suitable text-book on strength of materials for those engineering students, particularly architects, who have not studied the calculus. It embodies the experience of a number of years of teaching such students. A knowledge of algebra, trigonometry, and of theoretical mechanics, indulging centroids and moment of inertia, is presupposed. The topics discussed are those which are commonly taught engineering students in undergraduate courses in strength of materials. A few equations, such as Euler's column formula and the theorem of three moments, are stated and applied but are not derived. Deflection is studied by means of the areas of the shear, moment, and slope diagrams. The area of a plane surface bounded by a curve is computed by elementary calculus, the principles of which are outlined in an appendix. One chapter is devoted to a brief treatment of energy and repeated loads. Reinforced concrete beams are discussed as an example of beam action, and beams are designed and investigated with the derivation or use of many of the usual formulæ.

"Many problems are included, most of which are of a type met in practice but with the details simplified to emphasize principles. The problems are planned to assist in cultivating the judgment of the student in selection and use of data and in the reasonableness of the results."

THE EDITOR'S FORUM

BRITISH ARCHITECTS VISIT NEW YORK

ALTHOUGH foreign architects frequently visit our shores to more adequately familiarize themselves with what American architects are doing today, the recent visit of a group of leading English architects, members of the Royal Institute of British Architects, was a real compliment to the profession in this country. Although this visit of professional brethren from across the sea was far too brief to show them adequate hospitality or to give them more than an airplane view of the splendid examples of modern and classical architecture completed by us during the past ten years, everything possible was done to entertain these delightful gentlemen from England and to facilitate their progress through our architectural centers. During their brief visit of three days in New York, William A. Delano, President of the New York Chapter of the American Institute of Architects, entertained the visiting British architects at a small and informal luncheon at the Century Club. This sociable and delightful occasion gave an opportunity to a number of New York architects to meet and exchange ideas with this group of interesting and prominent British architects. The group consisted of Percy Thomas, Victor Wilkins, D. M. Laird, S. W. Davis, Laidlaw Smith, H. B. S. Gibbs, J. Gibson, and J. Parnie Dansken, Vice-president of the Faculty of Surveyors of Scotland.

It is sincerely to be wished that such meetings of British and American architects could occur more frequently. They would tend to produce a better understanding and a mutual appreciation and esteem and interchange of ideas between men who practice architecture on the opposite shores of the Atlantic.

A HOSPITAL COMPETITION

ARCHITECTS of New York are invited to enter into competition for the compilation of plans for the construction of a million dollar hospital plant, devoted exclusively to the health and welfare of women of the Bronx. The hospital is to be erected for the Bronx Maternity Hospital, on the site of its present building, 166th Street and the Grand Concourse, it was announced by Dr. Julius Wise, chairman of the building committee and consultant in charge of plans. Details of the desires of the board and advice and suggestions as to procedure will be given architects interested in the contest by Dr. Wise, who maintains offices at 748 Kelley Street, the Bronx.

The building will front 92 feet on the Grand Concourse and about 100 feet on East 166th Street. It will be a ten-story structure, ultra-modern in design and equipment, with a capacity of 250 beds. The design will run chiefly to wards, according to Dr. Wise, in order that facilities may be made available to the public at the lowest cost consistent with good service.

HENRY FORBES BIGELOW—1867-1929

FROM Boston comes the sad news of the death of another prominent architect, Henry Forbes Bigelow, who for many years has been one of the leaders of his profession in New England. He was graduated from St. Mark's School and later from the Architectural School of the Massachusetts Institute of Technology. For many years Mr. Bigelow has been a trustee of the Boston Museum of Fine Arts and, together with his partner, Philip Wadsworth, has built many important city and country houses in his native state, as well as the Hotel Touraine and the National Shawmut Bank in Boston, and the buildings for St. Mark's School. Possessed of a genial personality and a deep interest in his profession, Mr. Bigelow will be greatly missed by his many friends and by his professional associates.

A WAR MEMORIAL COMPETITION

THE War Memorial Committee of Chicago, consisting of W. Rufus Abbott, Sewell L. Avery, Gen. Abel Davis, Gen. Milton J. Foreman, Gen. Roy D. Keehn, Robert P. Lamont, Robert R. McCormick, Julius Rosenwald, Howard P. Savage, James Simpson (ex-officio Chairman of the Chicago Plan Commission), Albert A. Sprague and Walter Strong, desires to announce that a nation-wide competition will be held for the Chicago War Memorial, with attractive prizes and in accordance with the usage of the American Institute of Architects. Programs will be issued September 1 and judgment announced early in December. Under this general invitation programs may be obtained up to October 1 by qualified applicants from Earl H. Reed, Jr., Professional Adviser, 435 North Michigan Avenue, Chicago.

AN ARCHITECTURAL EXHIBITION

THE Philadelphia Chapter of the American Institute of Architects and the T Square Club will hold their 32nd annual architectural exhibition from November 1 to 15 inclusive. The joint exhibition board of the affiliated organization has announced that the exhibition will this year, through the courtesy of John Wanamaker, Philadelphia, be held in the well appointed art galleries of that firm.

A circular of information giving full details is now available which, together with entry slips and labels, may be had upon application to the Executive Secretary, at his office, 112 South 16th St., Philadelphia.

THE
ARCHITECTURAL FORUM

VOLUME LI SEPTEMBER 1929

CONTENTS

PART ONE—ARCHITECTURAL DESIGN

PART TWO—ARCHITECTURAL ENGINEERING AND BUSINESS

PARKER MORSE HOOPER, A.I.A., Editor
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MILTON BENNETT MEDARY
1874-1929

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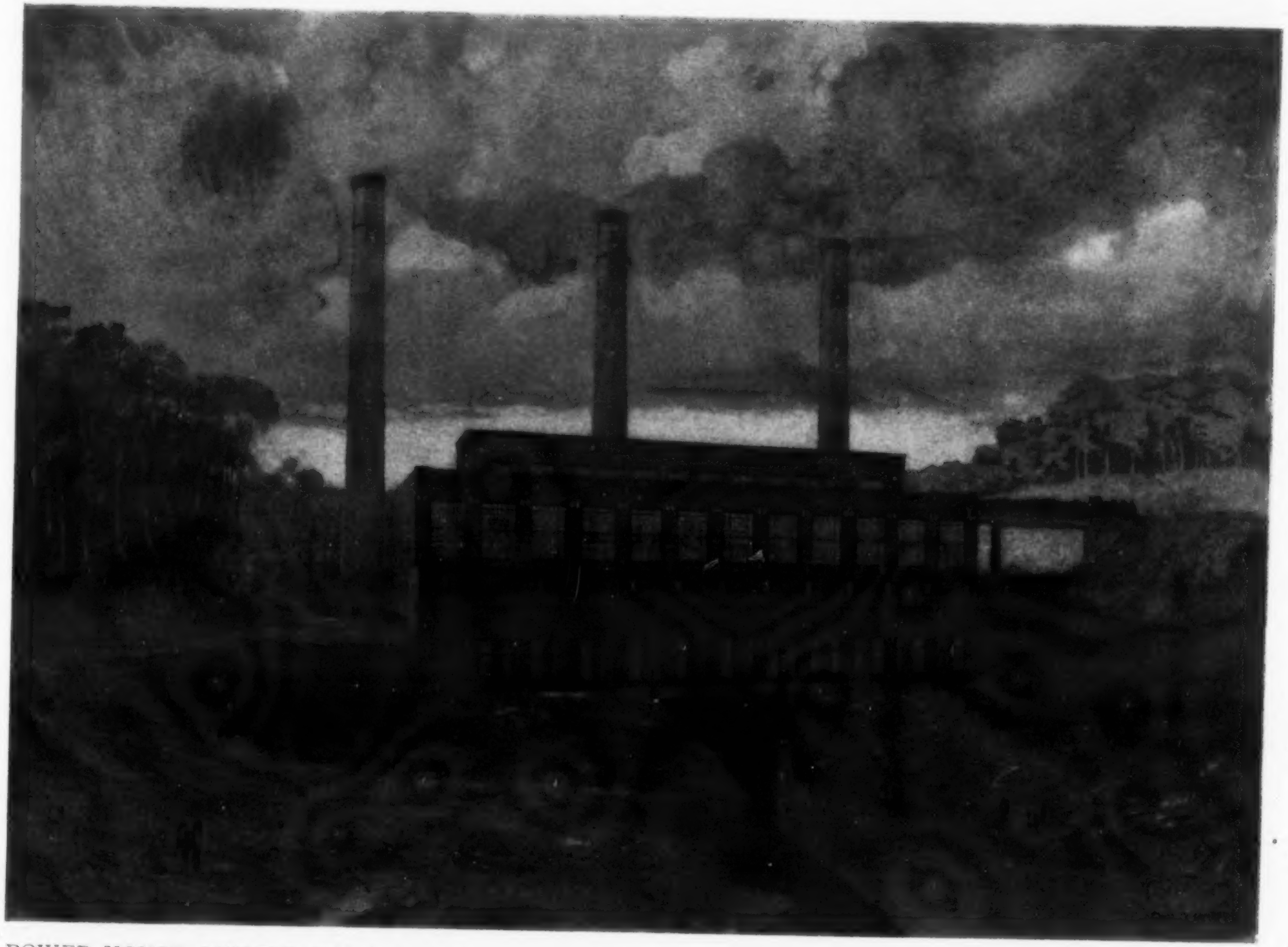
MILTON BENNETT MEDARY

1874—1929

BORN in Philadelphia on February 6, 1874, Milton Bennett Medary upon the completion of his school days entered the University of Pennsylvania, from which he was graduated. Four years later he formed the firm of Field & Medary, in which he was active in the practice of architecture until 1905. Following the dissolution of this firm, Mr. Medary worked alone until the formation, five years later, of the firm of Zantzinger, Borie & Medary, with which he was associated until his death. Mr. Medary was the designer of many important buildings in Philadelphia and in other parts of the country. Among his most recent achievements was the Carillon Tower, which he built for Edward W. Bok in the Bird Sanctuary at Mountain Lake, Fla.; the Pennsylvania Athletic Club; the Valley Forge Chapel; and the Fidelity Mutual Life Insurance Company's building in Philadelphia.

Milton Bennett Medary was for many years a leader in his chosen profession. Among the many honors accorded him were the degree of Doctor of Fine Arts from the University of Pennsylvania in 1927; the Presidency of the American Institute of Architects from May, 1926, to May, 1928; he was a director of the Foundation for Architectural and Landscape Architecture of Lake Forest, Ill., and was appointed a member of the National Commission of Fine Arts by President Harding in 1922, of the National Capital Park and Planning Commission by President Coolidge in 1926, and of the Board of Architectural Consultants of the Treasury Department by Secretary Mellon in 1927. He served as chairman of the Housing Corporation of the Department of Labor, and was appointed to design and construct workmen's villages at Neville Island, Pittsburgh, and Bethlehem, Pa., in 1918. He was consulting architect to Cornell University, Mt. Vernon on the Potomac, and the Roosevelt Memorial Association. While president of the American Institute of Architects, Mr. Medary took a great interest in directing the attention of the Institute to its powers of beneficial action in warning the public of commercial encroachment on places of great natural beauty. In October, 1927, the executive committee of the Institute adopted a resolution condemning establishment of any power development in the gorge of the Potomac River or in the Great Falls district of Washington, because it would destroy one of the beauties of the national capital. Such guarding of natural beauty Mr. Medary held to be a duty imposed on the architects of the entire country. In Philadelphia he was at one time president of the local chapter of the American Institute of Architects, the T Square Club, and of the Architectural Alumni of the University of Pennsylvania. He was a member of many other architectural societies, among which were the Philadelphia Zoölogical Society, and the American Game Protective Association. He was an honorary member of the American Society of Landscape Architects and an honorary corresponding member of the Royal Institute of British Architects.

Not only on account of his great devotion to the interests of the American Institute of Architects, but also because of his untiring work on behalf of the preservation and furtherance of the L'Enfant plan of Washington will Mr. Medary be remembered. In recognition of his untiring labor on behalf of the development of the architectural requirements of the national government in Washington, and on account of his high standing as an architect and as a man endowed with an unusual simplicity of manner, kindliness of personality, generosity of heart and high integrity of character, Milton Bennett Medary was awarded, in April, 1929, the Gold Medal of the American Institute of Architects. This event, which occurred only four short months ago, marked the culmination of a great career. Little did his friends realize that evening in the Corcoran Gallery of Art, when, after the glowing tribute by James Monroe Hewlett, Mr. Medary received from the hand of Secretary Mellon the highest honor which the American Institute of Architects has in its power to present, that this dearly loved, much admired and greatly honored man would so soon be taken from them. It was his good fortune to have lived a splendid life, full of devotion to his chosen profession.



POWER HOUSE, MUSCLE SHOALS, ALA.

EWING & CHAPPELL, ARCHITECTS

From an Oil Sketch by Chesley Bonestell

THE
ARCHITECTURAL
FORUM

VOLUME LI NUMBER THREE

SEPTEMBER 1929

PLANNING OF INDUSTRIAL BUILDINGS

BY
MORITZ KAHN
ALBERT KAHN, INC., ARCHITECTS AND ENGINEERS

IN this age of intensive production, when manufacturers will spare no reasonable expense in the purchase of effective equipment, it is surprising to find so many factory buildings which are improperly designed for economical production. Very often a poorly planned industrial building is the result of a lack of knowledge of the basic principles which govern the design of this type of structure.

The day has passed when a manufacturer can be satisfied with any kind of a building which is constructed merely for the purpose of keeping out the elements; a building poorly lighted and ventilated, with an improper system of heating, with wrong floor heights and column spacings; a building with a jumbled arrangement of entrances, stairs, elevators and internal departments, and with the many objectionable features which result in its being as depressing as it is impractical for production purposes. The enterprising manufacturer of today demands an effectively planned factory building, even as he requires an efficient installation of equipment. Some architects still feel that a snappy looking, symmetrical plan can always be made to fit the functions of a factory building, and that a Beaux-Arts elevation is all-sufficient for a successful scheme, losing sight of the fact that the sole purpose of a factory building is efficiency and economy of production so that the greatest possible yield is returned on the capital outlay.

There is no intention of conveying the impression that a factory building should be devoid of all decorative treatment, and that appearances are of little consequence in so prosaic a place as a factory. There is no reason why these buildings should be ugly. Treated with architectural skill all of them can at least be presentable, and often they can be made extremely imposing. If it can be obtained at little or no extra expense, and it can be, a pleasing elevation to a factory is worth having,—not only for its advertising value to the manufacturer, but also for the effect it has on employes. One of the most important things about an employe is his mental attitude toward his work, and one method of improving this attitude (not the only method, it is true, but nevertheless powerful) is to make his environment agreeable. But the designer of the factory building should continually bear in mind that every manufacturer is interested in dollars and cents first of all, and in appearances only secondly. A good appearance can be obtained without extra expense by the proper use of materials, by the general contour or shape of the building, by the accentuation of structural lines, by the proper proportioning of solids and voids or the massing of the structure. This form of decorative treatment does not increase the cost of the building, whereas an attempt to make an indifferent building presentable by applying ornament with a lavish hand is bound to prove a failure.

Probably the first important point to emphasize in the design of an industrial building is the need of planning it in coöperation with the manufacturer in order that the building may be designed for the specific purpose to which it is to be put. The character of the product and the processes of its manufacture must govern the design and type of the building to be used. Obviously, the manufacture of different kinds of products can be effectively carried on only in different types of buildings, each suited for the particular product to be manufactured. For example, the requirements in the manufacture of food products differ from those of a shoe factory; a motor assembly building will differ from a body construction building; a spring and upset building will differ from a steel rolling mill; and a foundry will be entirely different from a forge shop. While it is possible to manufacture food products and shoes in the same type of building, or to assemble cars

Engineering Laboratory, Ford Motor Company, Dearborn, Mich.
Albert Kahn, Inc., Architects and Engineers

and build bodies in the same type of structure, the adjustment of methods of manufacture to the particular type of building one happens to possess does not tend toward economical production. In other words, the method of production should not be adjusted to the building, but the building should be adapted to the production.

There are some general principles of industrial architecture which apply to all types of factories. To enumerate a few of them, the line of production should be continuous and direct; departments should be so located that material in course of production travels the shortest possible distance; there should be no crossing or confliction in the lines of travel which would result in congestion; departments should be so located that they can easily be re-located or expanded as any change in the manufacturing process or any growth in the industry may require; entrances, stairs and elevators should be located where they will afford the best means of access and where they will least interfere with the process layout; there should be an abundance of natural lighting and good ventilation; internal columns should be as few as possible compatible with economy of construction and should be so located as to permit the placing of equipment, causing the least interference with the flow of production; and floor heights should be adapted to the nature of the product and the methods of its manufacture.

Photos. Thomas Ellison

Forge Shop, Chevrolet Motor Company, Detroit
Albert Kahn, Inc., Architects and Engineers

Photo. Thomas Ellison

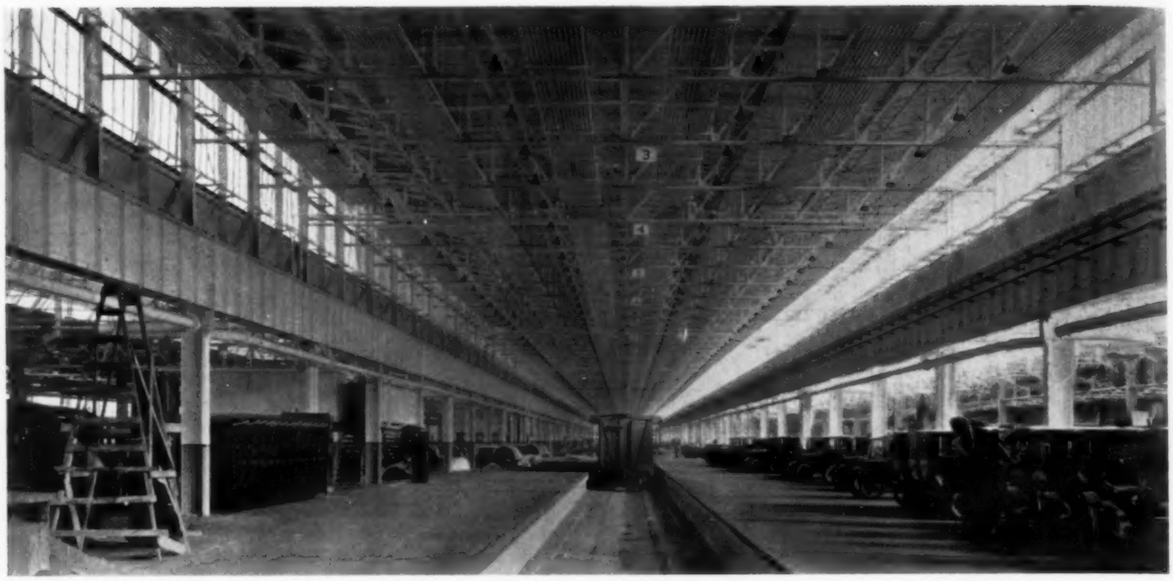
Plant for National Production Company, Detroit
Albert Kahn, Inc., Architects and Engineers

A well designed factory building will have a simplified plan,—in truth, the simpler the better. An intricate, though symmetrically balanced arrangement of departments, an interesting appearing plan might look well on paper from the architect's standpoint, but it will prove impractical from the works manager's point of view. The works manager must be unhampered in the arrangement of the departments and his equipment. For general manufacturing purposes it will suit him better to give him a clear open space which will permit him to arrange his departments as he thinks best, to re-arrange them whenever he finds it necessary on account of changes in methods of production, and to expand them in all directions when the growth of the industry requires. A proper plan of the main building will permit of horizontal expansion in any direction at any future time, and in the case of a multi-story building the foundations and columns can be designed strong enough to support future additional floors, thus allowing for upper expansion as may be necessary. In the general arrangement of a plant care should be exercised in the location of railroad sidings, driveways, power houses and auxiliary buildings, so as not to interfere with any future expansion.

For general manufacturing purposes, a standardized plan of building will prove to be of advantage. This refers particularly to such build-

Photo. Western Photo. Co.

Assembly Plant, Chevrolet Motor Company, Detroit
Albert Kahn, Inc., Architects and Engineers



Interior, Assembly Plant, Ford Motor Company, St. Paul
Albert Kahn, Inc., Architects and Engineers

ings as are used for motor assembly plants, or for the manufacture of bodies, motor parts, machine tools, food products, shoes, clothing and the like. In this type of factory the architect need only familiarize himself with the general method of manufacture, and the building need not be designed for any particular installation of equipment. There are other types of factory buildings, however, such as foundries, forge shops, cement plants, coal distillation plants, glass plants and the like which must be designed to fit particular schemes of equipment installation. In the first mentioned group of factories the building can be planned around the process of manufacture; in the second group the building must be designed around the equipment layout.

Body Building, Studebaker Corporation, South Bend, Ind.
Albert Kahn, Inc., Architects and Engineers

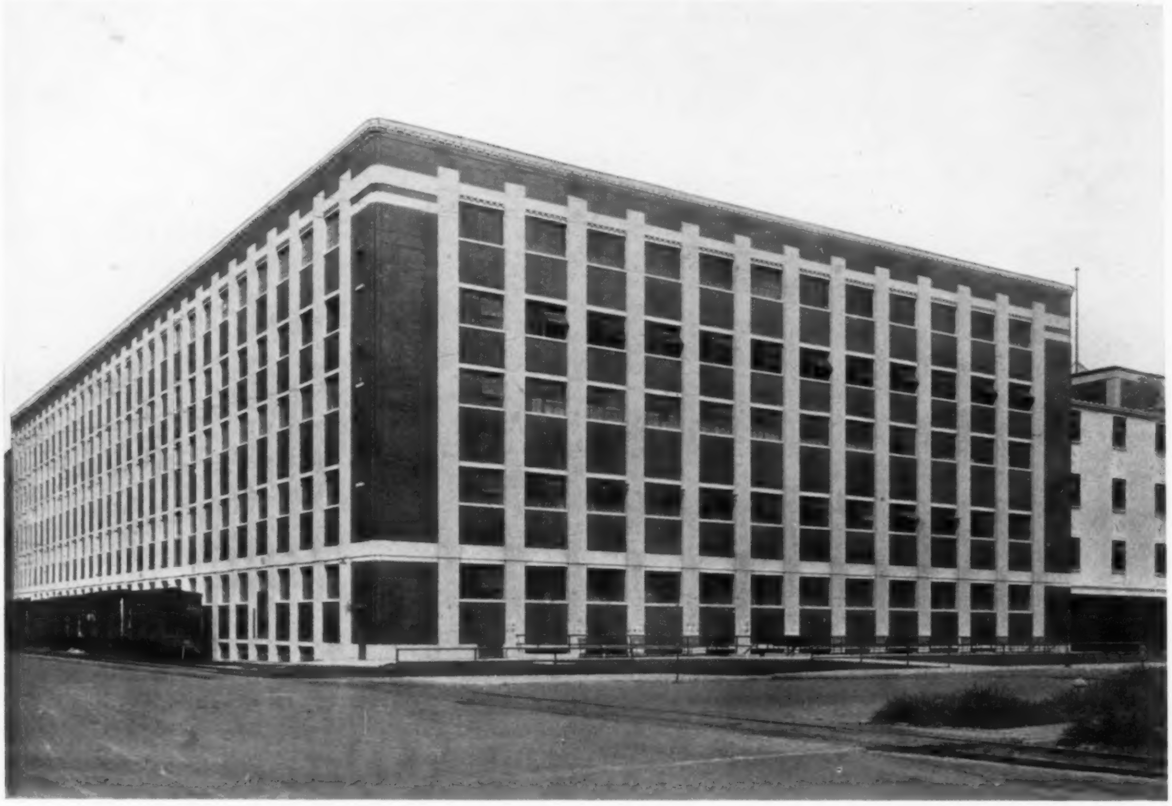
Photo. Thomas Ellison

Interior, Assembly Shop, Dodge Brothers, Inc., Detroit
Albert Kahn, Inc., Architects and Engineers

Before any building of the latter group can be designed, the architect must be in possession of the final equipment layout to make certain that the construction according to his plans will not interfere with the installation of the equipment.

It is difficult in an article of this length to dwell extensively on the structural features of industrial buildings, but here are some principles which should be observed by the designer of the factory. As previously intimated, there should be an abundance of natural lighting and ventilation. Windows should be as expansive as possible with an ample supply of opening ventilators. Daylight and fresh air cost nothing and consequently should be used to the greatest extent. The window or glass area should not be less

Warehouse, Detroit Railway & Harbor Terminals Company, Detroit
Albert Kahn, Inc., Architects and Engineers



Warehouse, Mishawaka Woolen Mills Company, Mishawaka, Ind.
Albert Kahn, Inc., Architects and Engineers

Photo. Manning Bros.
Factory for Mazer-Cressman Cigar Company, Detroit
Albert Kahn, Inc., Architects and Engineers

than 22¼ per cent of the floor area in the case of a multi-story building, and it may run as high as 30 per cent of the floor area in the case of a single-story building. Opening ventilators in side wall sash should not be less than 35 per cent of the total sash area and in monitors not less than 50 per cent of the sash area. The monitors affording roof lighting for single-story buildings should be so spaced as to give the greatest uniformity rather than intensity of lighting. Irregularity of lighting proves detrimental to the worker. The form or shape of the roof construction should be such as to promote natural ventilation which can be made to be as effective as, and always more economical than, forced.

No definite rules can be laid down for the spacing of columns, nor for story heights in the case of multi-story buildings. These conditions are governed by the nature of the product. For example, in the case of a multi-story building used for the manufacture of motor bodies, a clear distance of 22 feet between columns is most suitable, as this allows for two lines of conveyor tracks with just sufficient gangway for the workers. Again, in the case of a single-story building, say for a stove plant, columns spaced 35 feet center to center will prove most effective

Photo. Tebbs & Knell, Inc.

Packard Motor Car Service Building, New York

Albert Kahn, Inc., and Frank S. Parker, Associated, Architects

for economy of construction and working floor space. In general, however, it can be assumed that column spacing for multi-story buildings should fall between 20 and 30 feet center to center, and column spacing for single-story buildings should fall in the range of from 25 feet to 40 feet center to center.

It is likewise difficult to fix story heights of floors in case of multi-story buildings, because this also depends upon circumstances. For the average multi-story factory building a clear story height of 12 feet, 6 inches will prove practical for buildings of up to 100 feet in width, having unobstructed views on both sides to admit daylight. Single-story buildings, in general, should have a clear height of 14 feet to the under side of the roof trusses. This dimension, of course, does not take into consideration clearances for overhead cranes or conveyors which will require special treatment.

The disposition of entrances for stairways should be such as to afford the shortest and best means of access to the working spaces. Locker rooms and toilet rooms in expansive plants should not be concentrated in a few large units, but should be divided into many small units located around the plant so that the distances between

Photo. Manning Bros.

West End Plant, Fisher Body Corporation, Detroit

Albert Kahn, Inc., Architects and Engineers

them are not too great and to avoid excessive loss of time in their use by employes. In a single-story building, spread over a large area, toilet and locker rooms can, with advantage, be located on elevated platforms in the spaces between the roof trusses. This will save floor space and will eliminate interference with production, because the floor underneath can be used for production purposes, tool cribs, wash rooms, etc.

The floor finish of the factory building should be of a kind which is best suited for the particular department in which it is to be used. Where there is no excessive trucking in the transport of the product, or where conveyors are used for this purpose, the ordinary cement finish properly treated and hardened will prove adequate. In some departments, however, a cement finish is not suitable. For instance, in a tool room a wood floor will prove more satisfactory, because of the danger of injuring a tool dropped on a hard surface. In departments or gangways subject to certain types of trucking, a wood floor, either maple or wood block, may be necessary, because the trucking will dust up the surface of an ordinary concrete floor with consequent injury to the bearings of machinery; and, furthermore, the repair of a concrete floor necessitated by the wear of trucking is more difficult than the repair of wood flooring.

Factory buildings, whenever possible, should be constructed of fireproof materials. In the case of a fire, the loss of or injury to the building can be covered by fire insurance, it is true; but the loss due to disorganization or stoppage of output cannot be covered by insurance, and this is often of more importance than the monetary loss involved in the destruction of a building and its contents. Structural steel framing with brick walls and cement tile roofs will prove suitable for single-story buildings. In the case of multi-story factory buildings, reinforced concrete framework with brick enclosing walls will result in economy and will make possible expeditious construction, because the reinforced concrete work can usually be carried out in less time than is required in the preparation of shop drawings for and the fabrication of structural steel.

In such buildings where the use of elevators is necessary, the elevators should be spaced throughout the plant where they will prove of most efficiency and where they will not interfere with the flow of material in course of manufacture. Elevator platforms should be as large as possible, and high speed elevators should be used as extensively as possible. In factory buildings, where elevators are used, the elevators very often prove the "bottle neck," so to speak, of production. The best and speediest of elevators are never too good; any stoppage of elevator service means a stoppage of production, and while on this subject, a word could be said of elevator doors. The use of the best of doors, regardless of cost, is always advisable. As previously said, the manufacturer is always concerned regarding the cost of his building, which he naturally wishes to obtain at the lowest possible price. While factory buildings should be constructed as economically as possible, the economies should result from close study of structural details and the best use of structural materials. The designer should not attempt to produce economies by using cheap elevators and cheap elevator doors. No manufacturer will be thankful to a designer who saves a few thousand dollars on an elevator installation which is continually causing stoppage of output, and consequent continual money loss.

In conclusion it is well to call attention to the fact that an architect who specializes in the design of industrial buildings is not expected to be an expert in process layout. The works manager is best capable of preparing his own process diagram. Being in possession of such a diagram, the architect should confine his efforts to building around that layout a factory which is best suited to the scheme of operation. The specialist designer need possess merely a general knowledge of the principles of manufacture. He should, however, be fairly well acquainted with the nature and possibilities of mechanical equipment, and of the requirements of power and shafting; he should be conversant with floor heights as governed by various processes of manufacture; he should be able to design efficient heating, ventilating and artificial lighting installations and, above all, he should be able to advise upon the most suitable type of structure required for the manufacture of a specific product. It would be expecting too much of any designer to be master of all the principles that enter into the design of industrial buildings, and therefore the architect who wishes to specialize in this field of work is well advised in surrounding himself with a staff of assistants, each of whom will be especially qualified in his particular sphere. With such a staff under his direction and management, the architect will prove of great value to the manufacturer.

So rapidly have the industries of this country grown and developed in the past 70 years that there has been little time or opportunity for the work of the trained architect in the designing of such buildings. Today it is a matter of pride among the industries, great and small, to erect buildings planned for the most efficient installation of machinery and equipment and to design them along carefully studied architectural lines.

THE ARCHITECTURE OF INDUSTRIAL BUILDINGS

BY

ELY JACQUES KAHN

PREACHING the doctrine of modernism has its entertaining reactions. A man believes that he himself sees the light and discovers that the beam he has noticed is merely a reflection of the illumination all about him. The moment has acknowledged the existence of a point of view entirely at variance with that of a generation past, and in the architecture of the industrial building in particular, the result is sweeping. Where domestic work resists, grimly, the elimination of faked "quaintness," and where likewise the monumental building disdainfully avoids variation from precedent, the industrial structure sails merrily into experiment. Here common sense,—the engineering instinct, cost, income,—predominates. Beauty comes as a result of the solution of a problem where use of extraneous material or mere picturesqueness would be absurd.

It is evident that the new design of this type of structure dates from the first use of steel or reinforced lintels where large glass areas were possible. The curious factory structures with heavy brick walls and small windows,—if they still exist,—are merely awaiting the pickaxe of tomorrow's demolition. Light and ventilation are paramount. The engineer smiles and suggests that the more modern conception would be that of purely scientific illumination by electricity; uniform distribution of the color and intensity of light required; ventilation to be effected by change of air at required intervals; the air itself to be regulated in moisture and temperature. Interesting theory, and very often essential in spite of the presence of windows

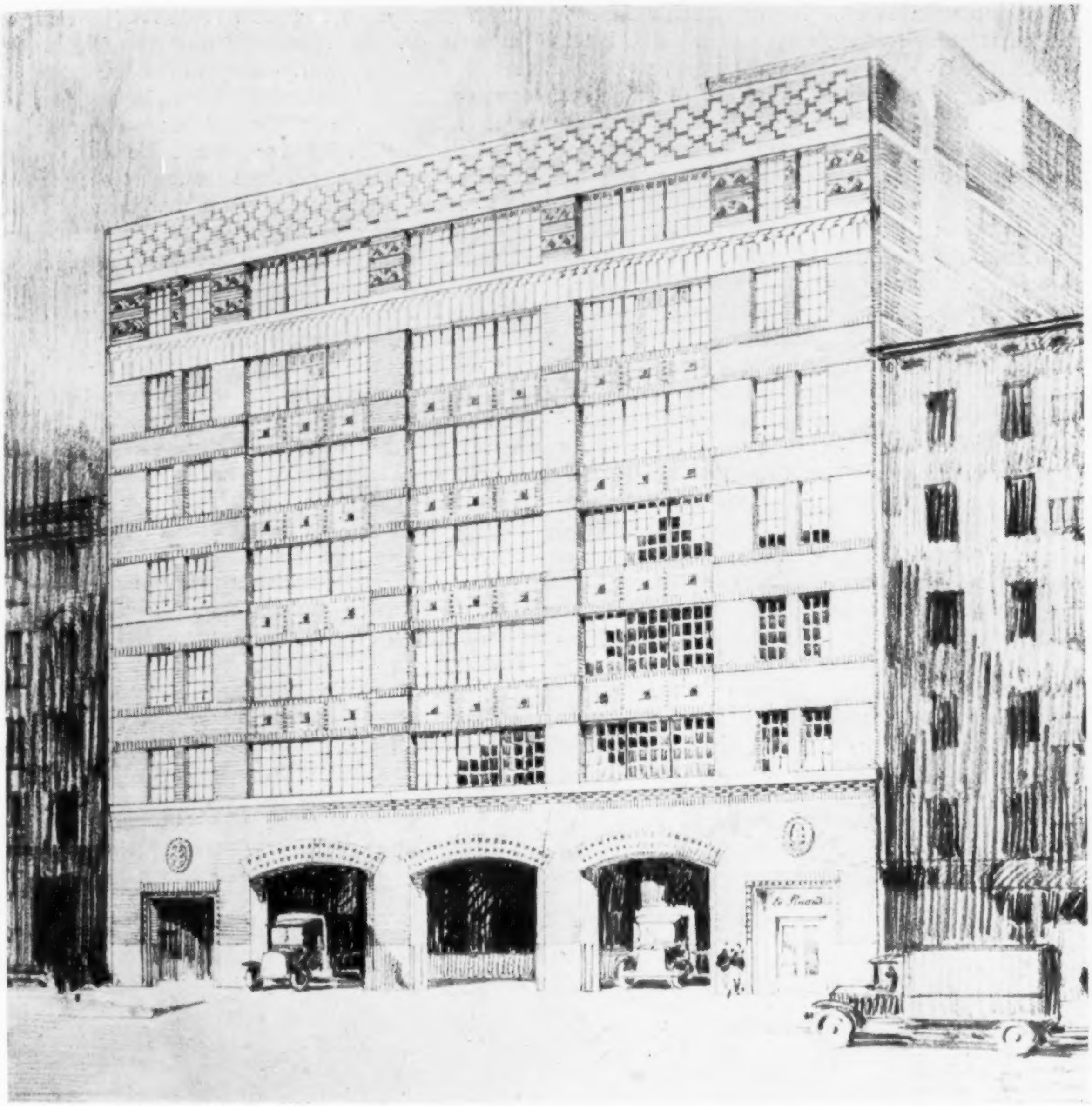
Photos. Tebbs & Knell, Inc.

U. S. Appraisers' Stores, New York
Buchman & Kahn, Architects

U. S. Appraisers' Stores, New York
Buchman & Kahn, Architects

which, though in some instances they may be of major importance, in others are permitted purely on sentimental allowance to the traditional instincts of employes who object to being shut off from a glimpse of what is occurring outside.

The industrial building is primarily and definitely a machine for the production of a commodity. The solutions to its problem can vary in material or detail, but, basically, the structure must answer its purpose. The column arrangement must properly fit the lines of machines, the receptacles for merchandise, the handling of goods for packing or shipping. There are, quite obviously, varying types of industrial structures that include the very tall factory buildings of New York, as well as the one-story, roof-lighted shed type of mill that is found outside of the cities and on cheaper land. The tall buildings of the Garment Center in New York, the printing buildings developing in the Varick Street section and likewise in the forties east of Lexington Avenue, represent a characteristically large city type of factory. In New York, in particular, this type of structure has had intense development. Through real estate sales pressure, to a large extent, manufacturers have been brought together. The clothing trades, the silk, wool, leather, toy and furniture industries concentrate in definite districts where it is apparently convenient for the buyer to find



From the Architects' Rendering

Pinaud Building, New York
Buchman & Kahn, Architects

his market and where the subsidiary businesses likewise cluster to avoid unnecessary loss of time in transacting their affairs. With this most persistent grouping there has come the problem of freight traffic,—the actual handling of the enormous quantities of goods of every nature. The clothing district in New York, for example, in turn attracts the various supply houses that handle fabrics,—silk, cotton, wool and rayon.

As the manufacturers find it difficult to conduct production on a large scale in locations where rents are relatively high and shipping conditions unfavorable, many of the large buildings develop into sales offices, finished stock rooms and executive offices, with the actual producing plants outside of the city or in sections of the New York area that are more adaptable. In the very tall New York factory structure, the standard of height has increased in the last ten years in a steadily rising scale. Where 16 floors was normal in 1920, 18 and 20 appeared later, until in this year monsters of 30 and more are commonplace. The results, considering the restrictions of zoning conditions for relatively small lots, develop large units of ground area and improved elevator and freight facilities.

The street traffic situation is one of the factors which will seriously endanger the steady growth of such districts. There is no question but that the manufacturer will presently object

to the inconvenience of losing valuable time by the most absurd street congestion. The building can be as well planned as may be possible with modern facilities of every conceivable type, and yet if the moment the merchandise comes to the street traffic is stopped, the building cannot be successful. The difficulty naturally has to do with an entirely unreasonable city plan,—narrow streets, intense through and cross circulation, and no direct arteries. The solution is yet to be found, though freight tunnels, secondary streets, may be less visionary when the actual demand insists on finding them.

The large buildings are highly specialized in equipment. The elevators and freight halls are designed to accommodate particular industries. Furniture, for example, requires large elevator cars in which bulky pieces can speedily be transferred; the floor loads are light. Millinery buildings require column arrangements adaptable to a number of small machines,—live steam for essential steps of manufacture; high ceilings for freight corridors because of the bulk of the cardboard boxes in which finished product is shipped. In other buildings the finished articles are handled mainly in express package form, so that provision must be made for express collecting and checking, independently of the constant entry of bulky raw material. In the design of these great units, low cost is naturally of major importance. Economy of plan and avoidance of areas that are poorly adapted to the uses intended, are paramount. Windows have to be arranged to provide sufficient light; the mechanical requirements as to live steam, electric power, ventilating shafts, package chutes are of importance. In the factory building, high or low, column spacing seems to be the most important consideration. When the bays become too large, excess cost of columns and steel framing appears. Normal ceiling heights would likewise be affected by inordinately deep girders. In printing buildings the variation in sizes between heavy newspaper presses and the smaller types for normal printing of books and commercial production of every sort, determines the necessary clearance requirements, in walls and floor loads. Vibration under the stress of heavy machinery must be avoided by adequate load capacity and proper reinforcing.

The industrial structures problem demands in the first instance an engineering solution. Areas conveniently disposed; adequate light; proper facilities for the transaction of the business in hand are necessary. There can be no modernity in design that does not begin with such principles, and through such logical steps and the elimination of unnecessary decorative features it is

Interior, U. S. Appraisers' Stores, New York
Buchman & Kahn, Architects

possible that something new may develop. In fact, it is obvious that this must be the case, for every day's problem demands a new solution, whether it be the question of an aëroplane factory, a hangar, or a building for the handling of some new product that requires specific space, height, illumination. The major difficulty of the designer of industrial structures is that he is still conscious of the existence of an æsthetic problem. The untrained person, when he finishes what he considers a satisfactory solution of his practical problem, adds curious inserts of tile, bits of carving, or a mongrel door to satisfy some yearning for decoration. The fact that fine proportion, balance of mass, and agreeable color of material are more important, fails him.

The great hangar at Orlay is a splendid piece of design that needs no ornament to improve it. The great factory buildings of Peter Behrens in Berlin and the buildings at Dessau are equally vigorous and require no apologies for being of this day. The successful industrial establishment exists primarily and lastly to serve a functional purpose. If it succeeds in that it is almost obvious that it will be agreeable to look at for the same reason that the machine itself is attractive,—there is nothing extraneous, and the proportions are normal to a working unit. It is only when the designer begins to inject æsthetics that the danger arises. There is no thought in this of minimizing the importance of the trained designer, but particularly the checking of the enthusiast who will distort a fine mechanism to simulate some classic monument or trifle with the simplicity and clarity of fine mass and proportion, which is almost always a failure.

Photos. Sigurd Fischer

Door Detail, Pinaud Building, New York

Buchman & Kahn, Architects

PINAUD BUILDING, NEW YORK
BUCHMAN & KAHN, ARCHITECTS

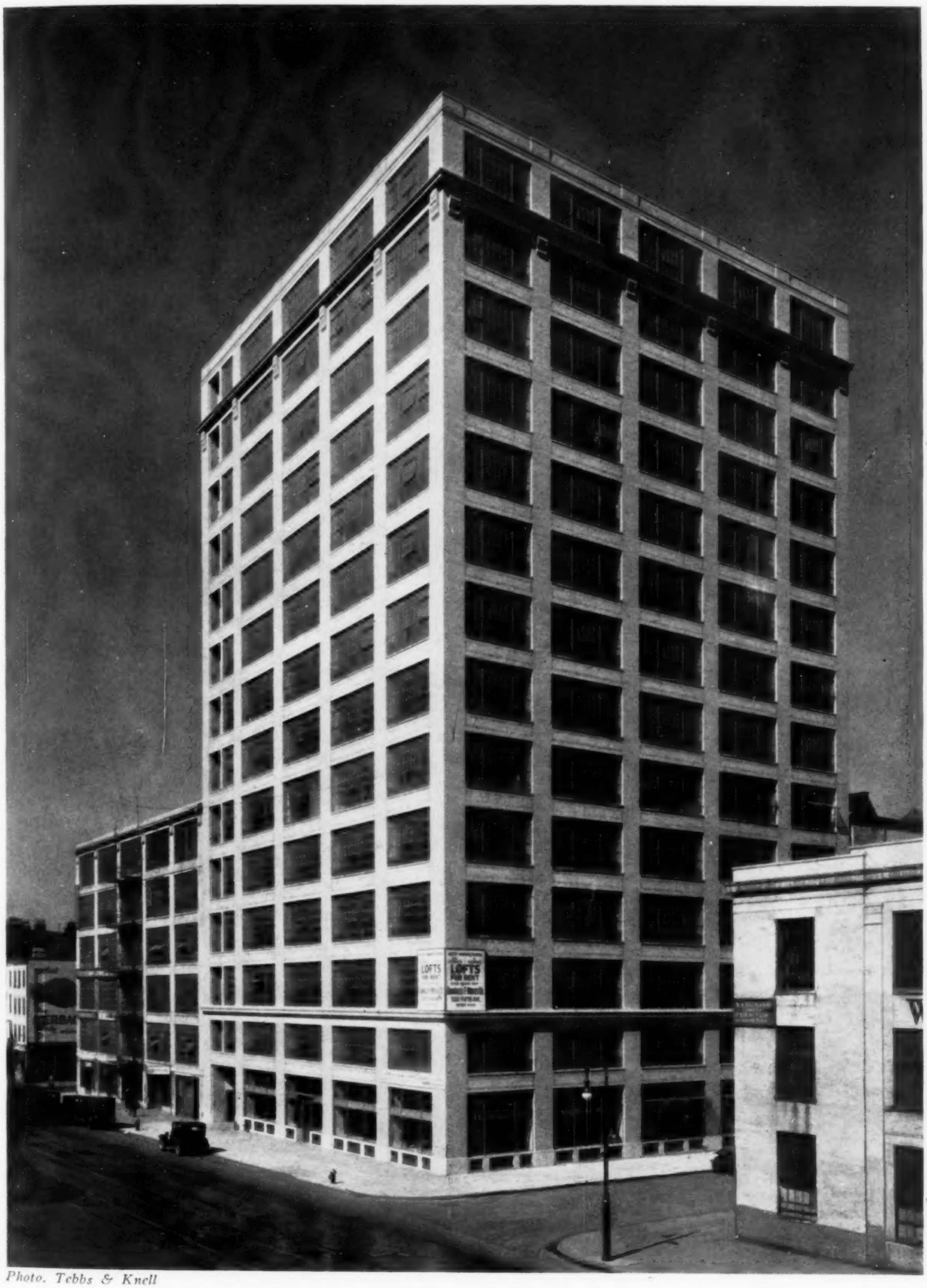
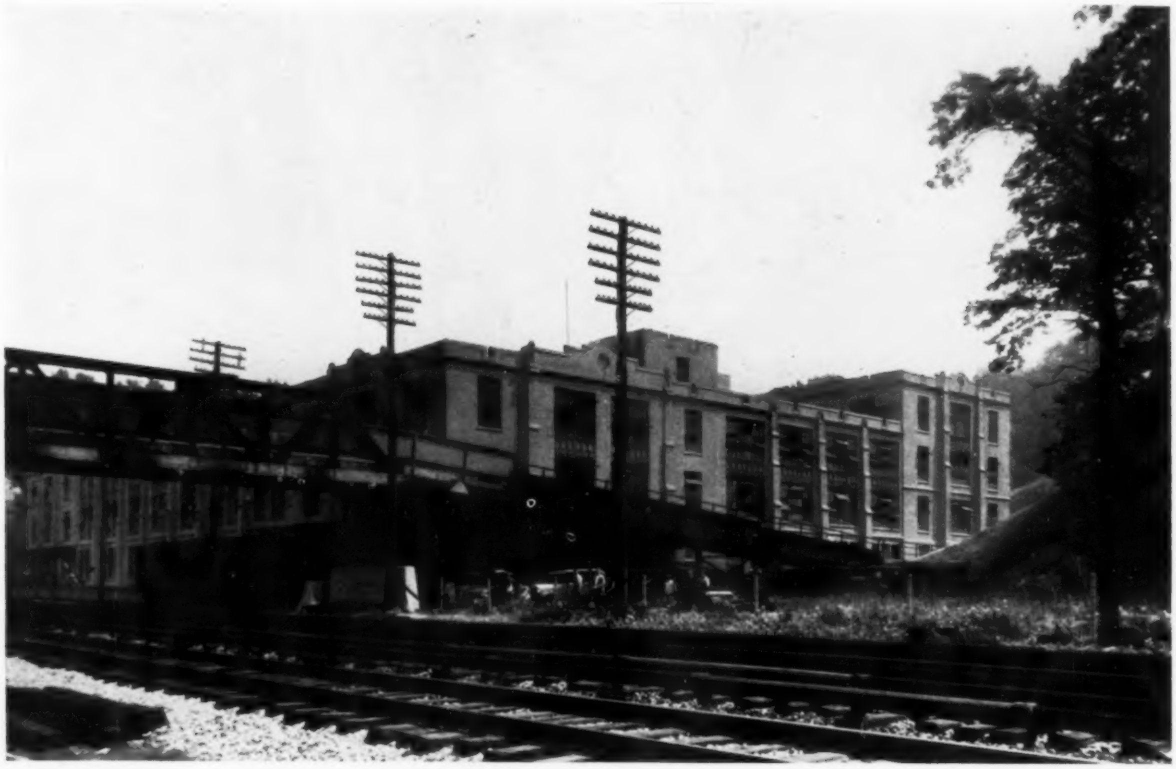


Photo. Tebbs & Knell

LOFT BUILDING, 639 ELEVENTH AVENUE, NEW YORK
ERNEST FLAGG, ARCHITECT



Photos. George H. Van Anda

BUILDING OF METHODIST BOOK CONCERN, DOBBS FERRY, N. Y.

VISSCHER & BURLEY, ARCHITECTS

Plan on Back

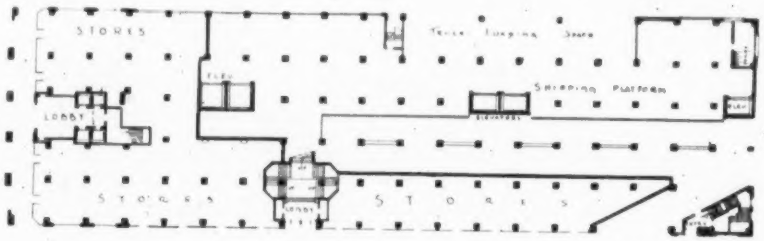
COE TERMINAL WAREHOUSE, DETROIT
S. SCOTT JOY, ARCHITECT

Plan on Back

NORTH STATION INDUSTRIAL BUILDING, BOSTON
S. SCOTT JOY, ARCHITECT

COST AND CONSTRUCTION DATA

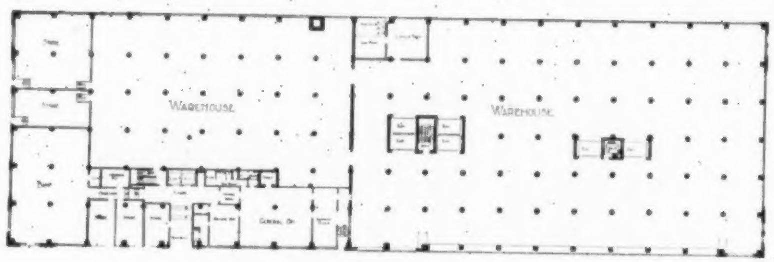
Year of Completion: 1929.
Type of Construction: Flat slab and some steel column cores.
Exterior Materials: Face brick, composite stone and concrete.
Floors: Cement.
Windows: Steel sash.
Heating: Steam metered from distant plant.
Cubic Foot Cost: 25 cents, exclusive of architect's fee.
Total Cost: $1,664,137, exclusive of architect's fee.
Use of Building: Heavy warehouse and loft building.



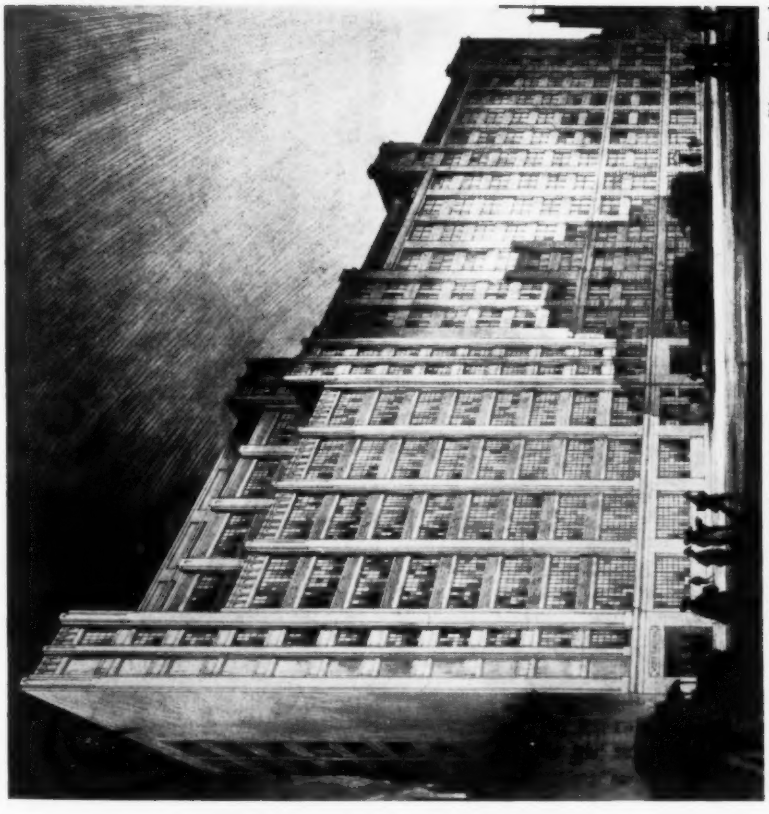
FIRST FLOOR
PLAN, NORTH STATION INDUSTRIAL BUILDING, BOSTON
S. SCOTT JOY, ARCHITECT

COST AND CONSTRUCTION DATA

Year of Completion: 1927.
Type of Construction: Flat slab.
Exterior Materials: Face brick, terra cotta and concrete.
Floors: Cement.
Windows: Steel sash.
Heating: Low pressure steam.
Cubic Foot Cost: 21 cents, exclusive of architect's fee.
Total Cost: $952,067, exclusive of architect's fee.
Use of Building: Heavy warehouse and loft building.



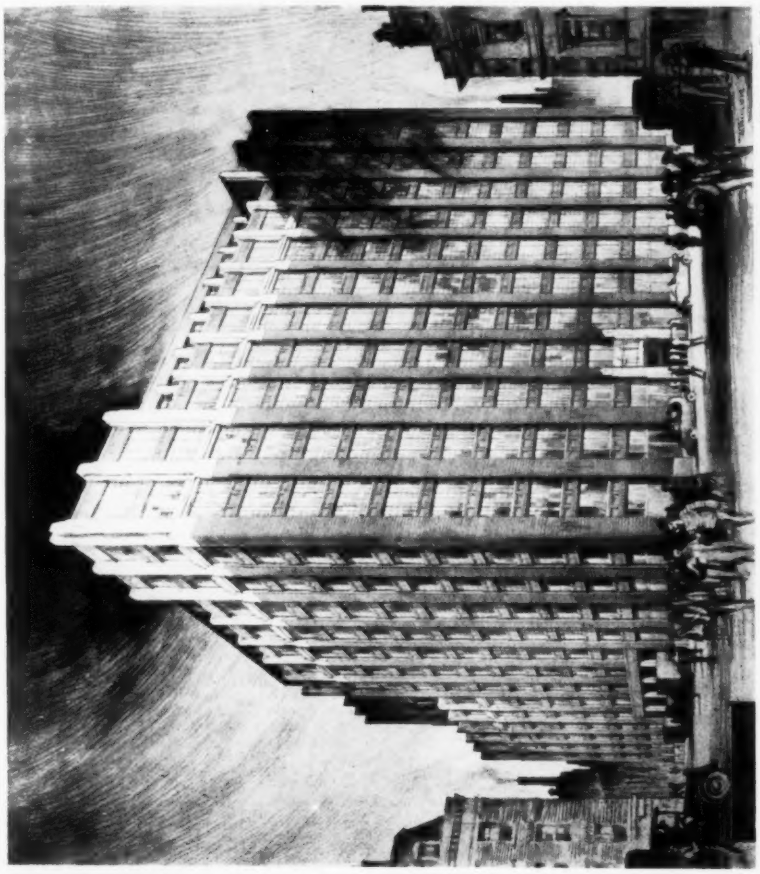
FIRST FLOOR
PLAN, COE TERMINAL WAREHOUSE, DETROIT
S. SCOTT JOY, ARCHITECT



From the Architect's Preliminary Sketches *Plan on Back*

ADDITION TO WOLFF BOOK BINDERY, NEW YORK

FRANK S. PARKER, ARCHITECT AND ENGINEER



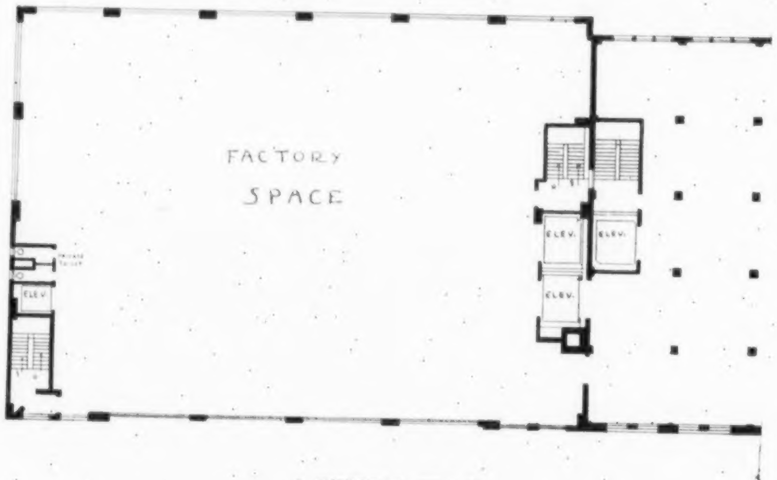
Plan on Back

GRAPHIC ARTS CENTER, NEW YORK

FRANK S. PARKER, ARCHITECT AND ENGINEER

COST AND CONSTRUCTION DATA

Year of Completion: 1926.
Type of Construction: Reinforced concrete.
Exterior Materials: Concrete and brick.
Interior Materials: Concrete and brick.
Floors: Concrete.
Windows: Factory type steel sash.
Heating: Vacuum, low pressure.
Cubic Foot Cost: 26 cents.
Total Cost: $502,000, exclusive of land and financing.
Use of Building: Bookbinding, printing and allied trades.

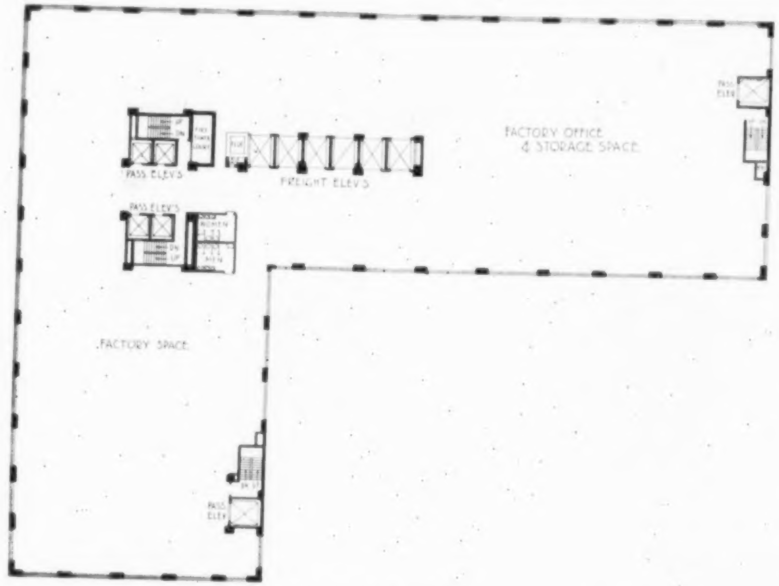


A TYPICAL FLOOR

PLAN, ADDITION TO WOLFF BOOK BINDERY, NEW YORK
FRANK S. PARKER, ARCHITECT AND ENGINEER

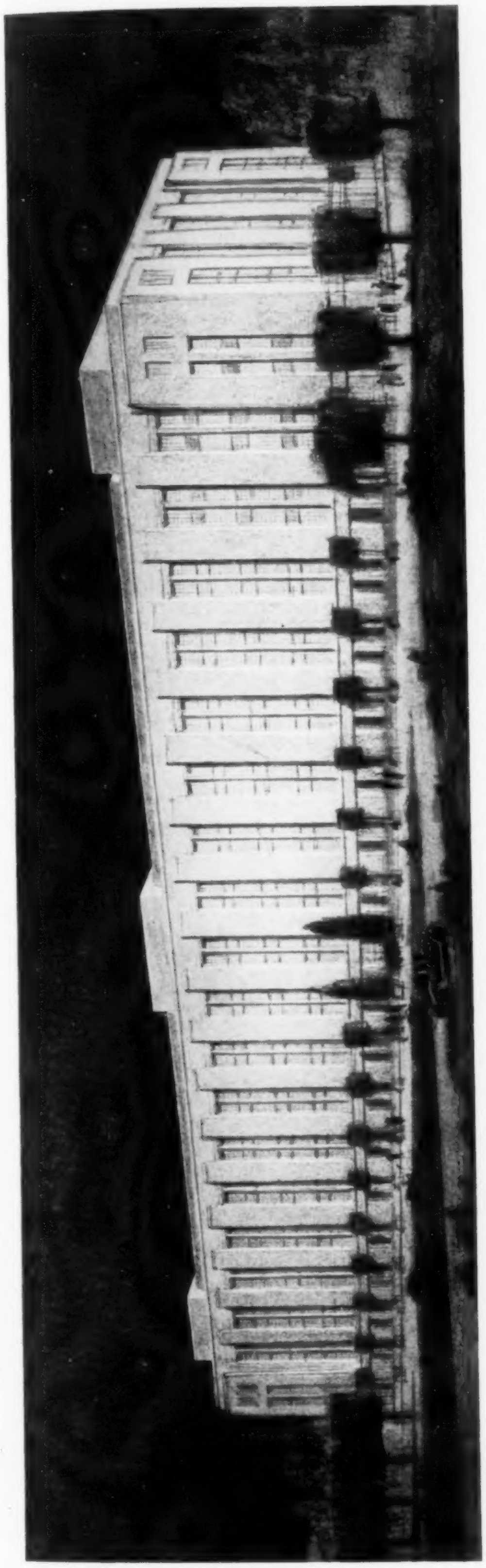
COST AND CONSTRUCTION DATA

Year of Completion: 1927.
Type of Construction: Reinforced concrete.
Exterior Materials: Brick, limestone, granite.
Interior Materials: Concrete, brick, terra cotta.
Floors: Concrete.
Windows: Factory type steel sash.
Heating: Vacuum system, steel boilers, low pressure.
Cubic Foot Cost: 24 cents.
Total Cost: $1,400,000, exclusive of land and financing charges.
Use of Building: Printing and heavy manufacturing.

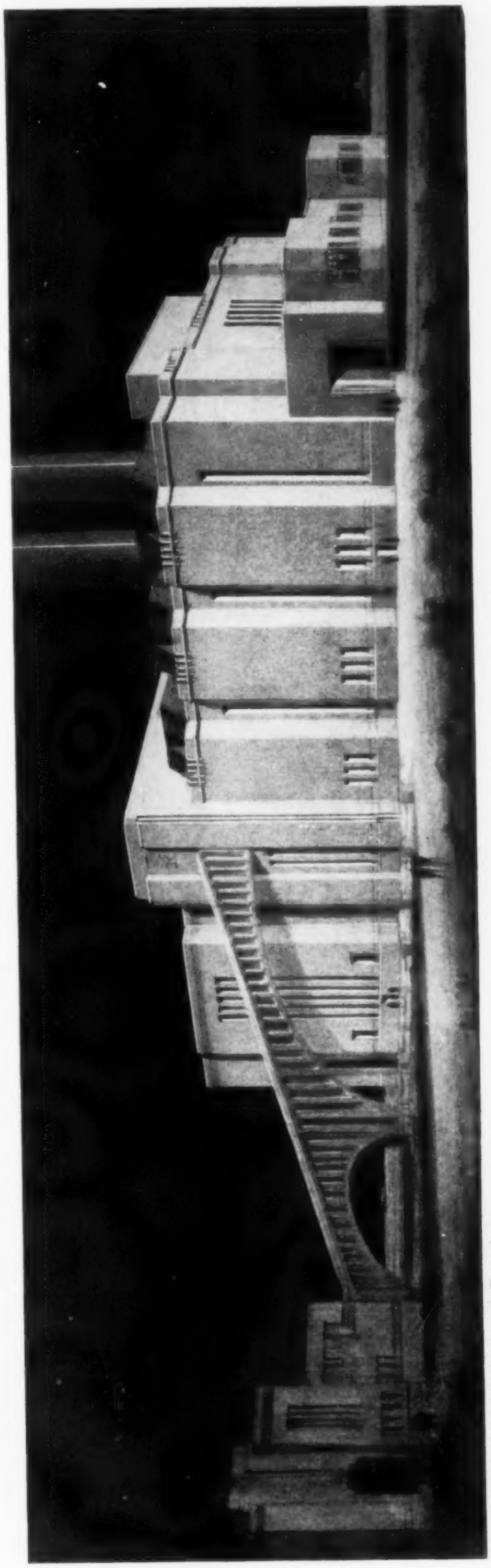


A TYPICAL FLOOR

PLAN, GRAPHIC ARTS CENTER, NEW YORK
FRANK S. PARKER, ARCHITECT AND ENGINEER



BUILDING FOR THE JEWEL TEA COMPANY, BARRINGTON, ILL.
HOLABIRD & ROOT, ARCHITECTS



From the Architects' Rendered Drawing

POWER HOUSE, MICHIGAN CITY, IND.
HOLABIRD & ROOT, ARCHITECTS

GENERAL VIEW

Photos, Mott Studios *Plan on Back*

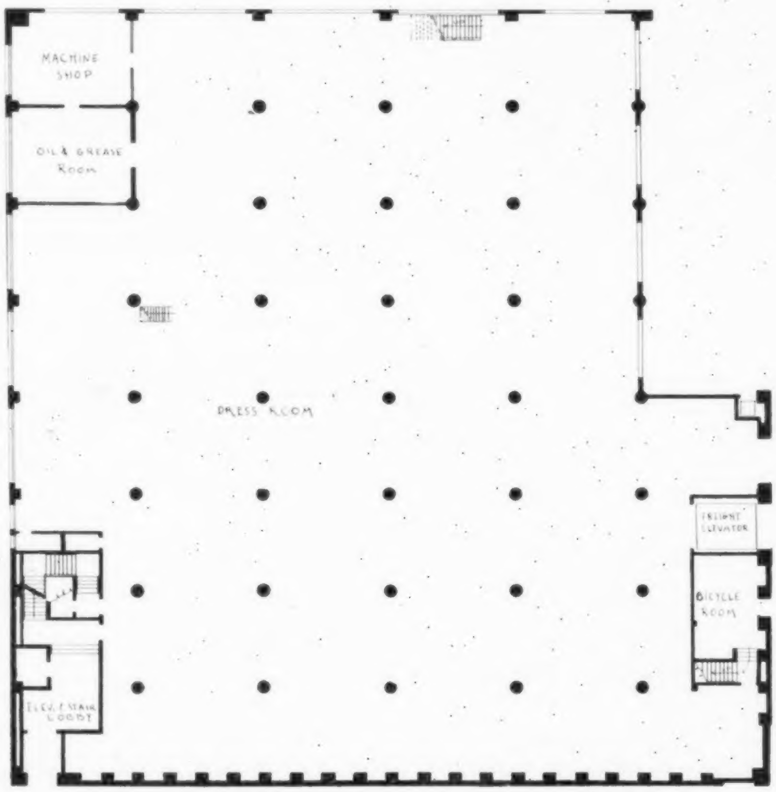
ENTRANCE DETAIL

PRINTING PLANT, LOS ANGELES DOWNTOWN SHOPPING NEWS

MORGAN, WALLS & CLEMENTS, ARCHITECTS

COST AND CONSTRUCTION DATA

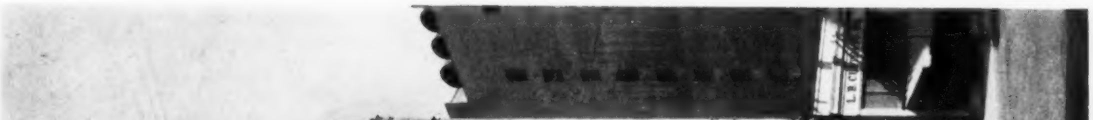
Year of Completion: 1928.
Type of Construction: Reinforced concrete.
Exterior Materials: Plaster, cast stone trim.
Windows: Steel sash.
Lighting: Direct, with some special and some indirect.
Heating: Gas steam radiators.
Ventilation: Mechanical exhaust system serving some portions of building.
Cubic Foot Cost: 23 cents.
Total Cost: $323,000.
Use of Building: Newspaper printing plant.



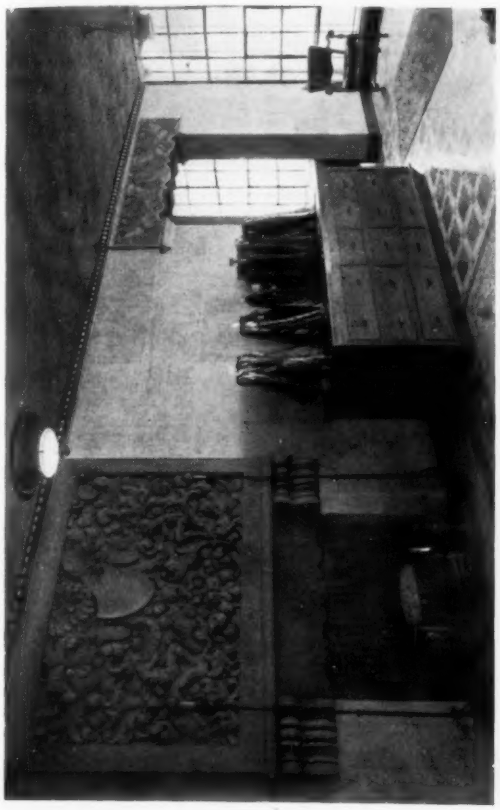
FIRST FLOOR

PLAN, PRINTING PLANT, LOS ANGELES DOWNTOWN SHOPPING NEWS

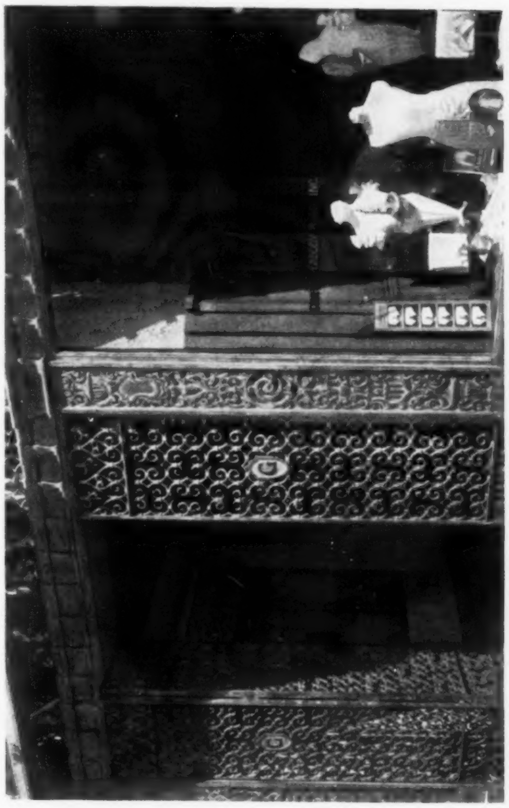
MORGAN, WALLS & CLEMENTS, ARCHITECTS



GENERAL VIEW



SALES ROOM



MAIN ENTRANCE

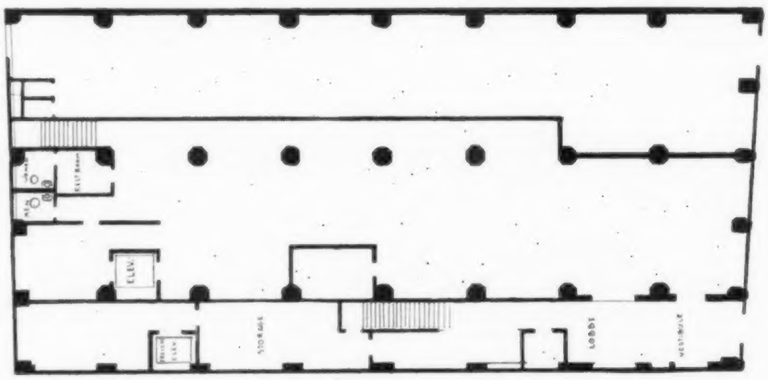
GRAYCO SHIRT FACTORY, LOS ANGELES
MORGAN, WALLS & CLEMENTS, ARCHITECTS

Photos. Mott Studios

Plan on Back

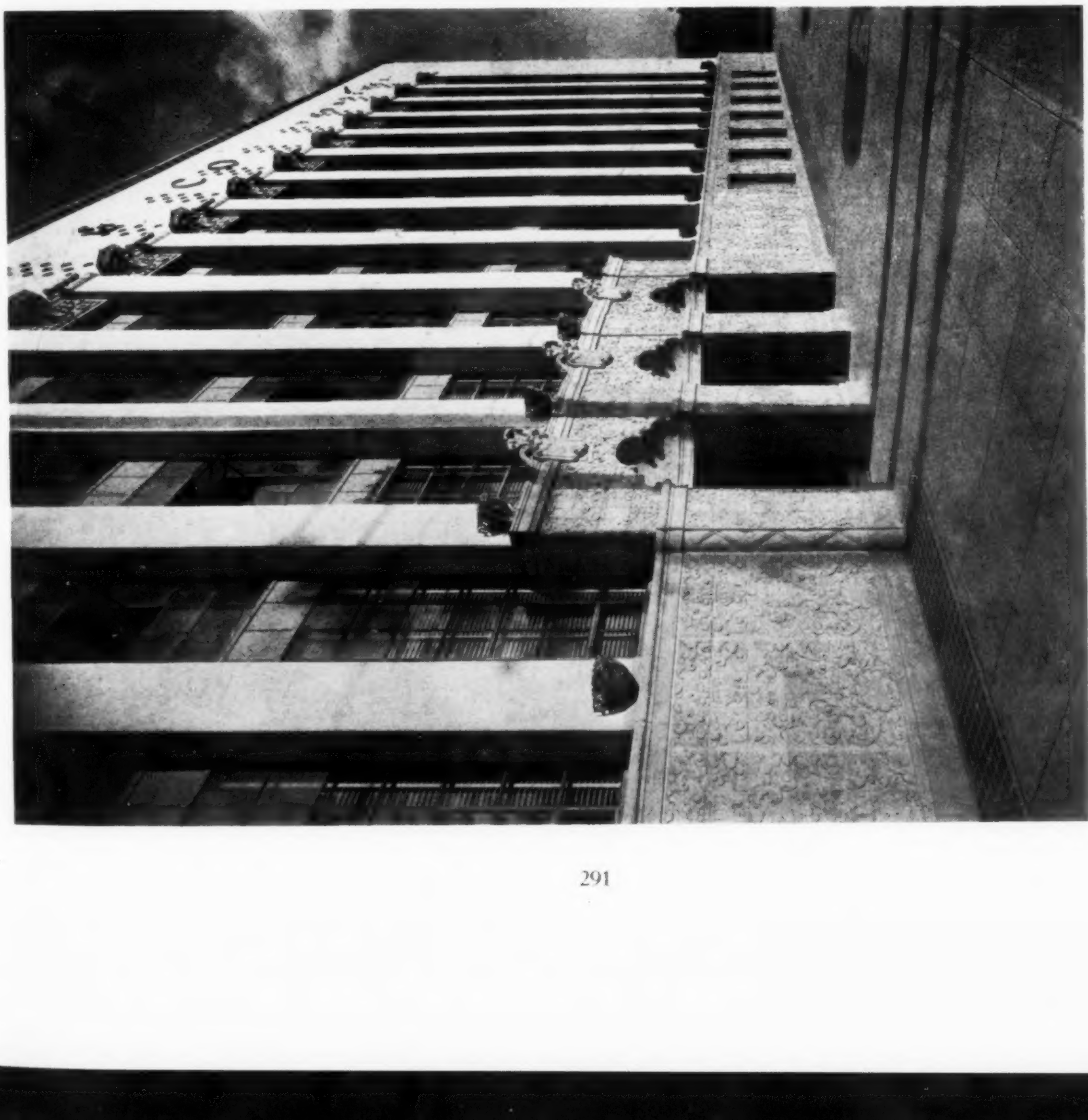
COST AND CONSTRUCTION DATA

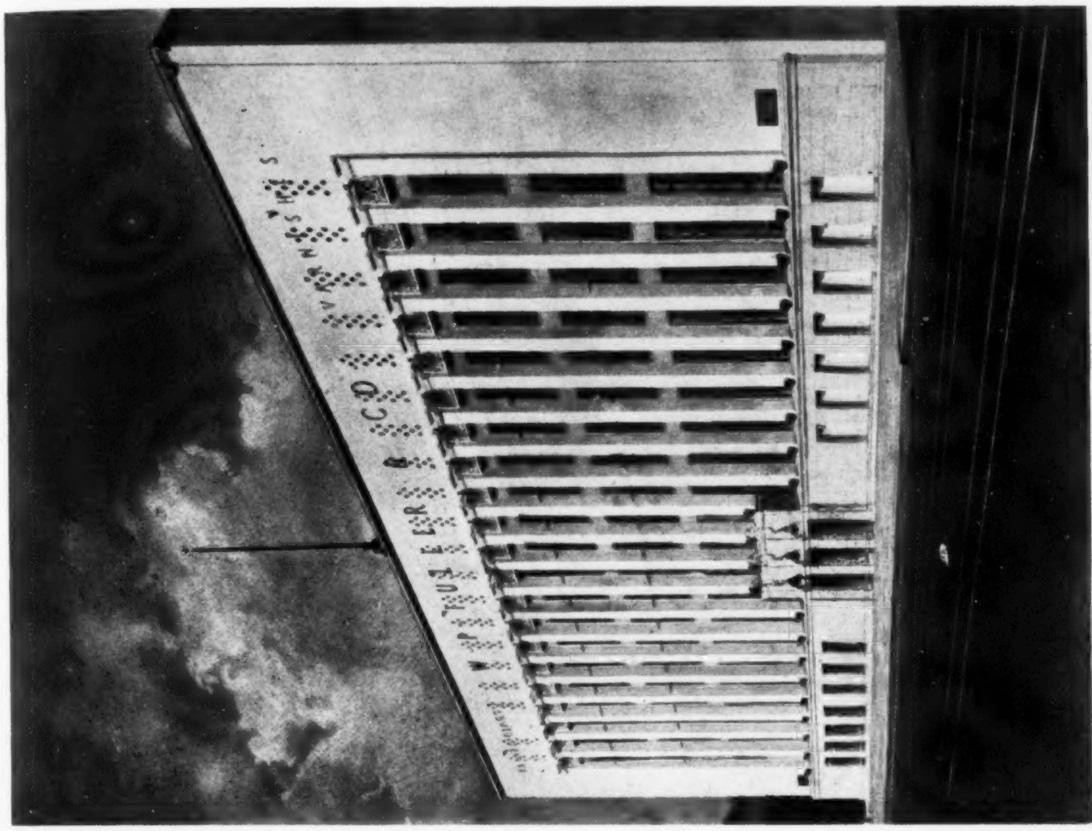
Year of Completion: 1926.
Type of Construction: Reinforced concrete.
Exterior Materials: Plaster, cast stone trim, wrought iron grilles.
Floors: Cement, and rubber tile in shops.
Windows: Steel sash.
Lighting: General illumination.
Heating: Gas steam radiators.
Cubic Foot Cost: 20 cents.
Total Cost: $136,000.
Use of Building: Shirt factory.



MAIN FLOOR

PLAN. GRAYCO SHIRT FACTORY, LOS ANGELES
MORGAN, WALLS & CLEMENTS, ARCHITECTS





Photos, Mott Studios

MAIN ENTRANCE

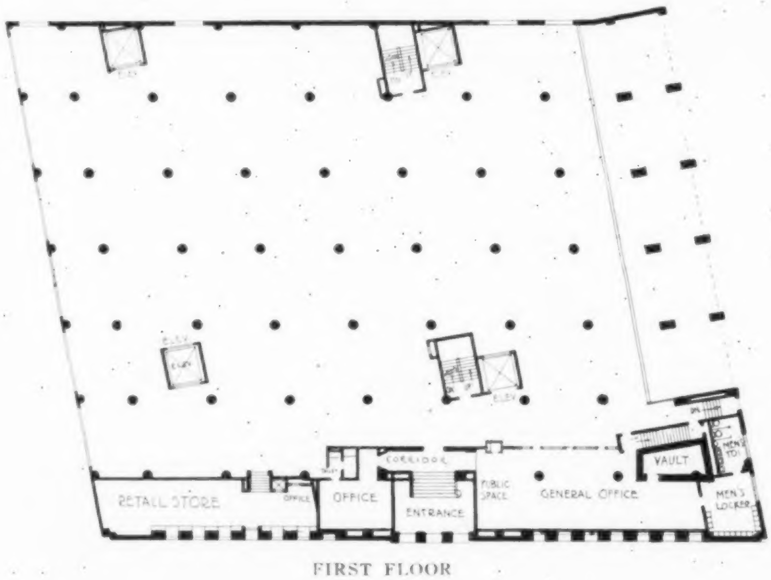
FRONT FACADE

W. P. FULLER & CO. WAREHOUSE, LOS ANGELES
MORGAN, WALLS & CLEMENTS, ARCHITECTS

Plan on Back

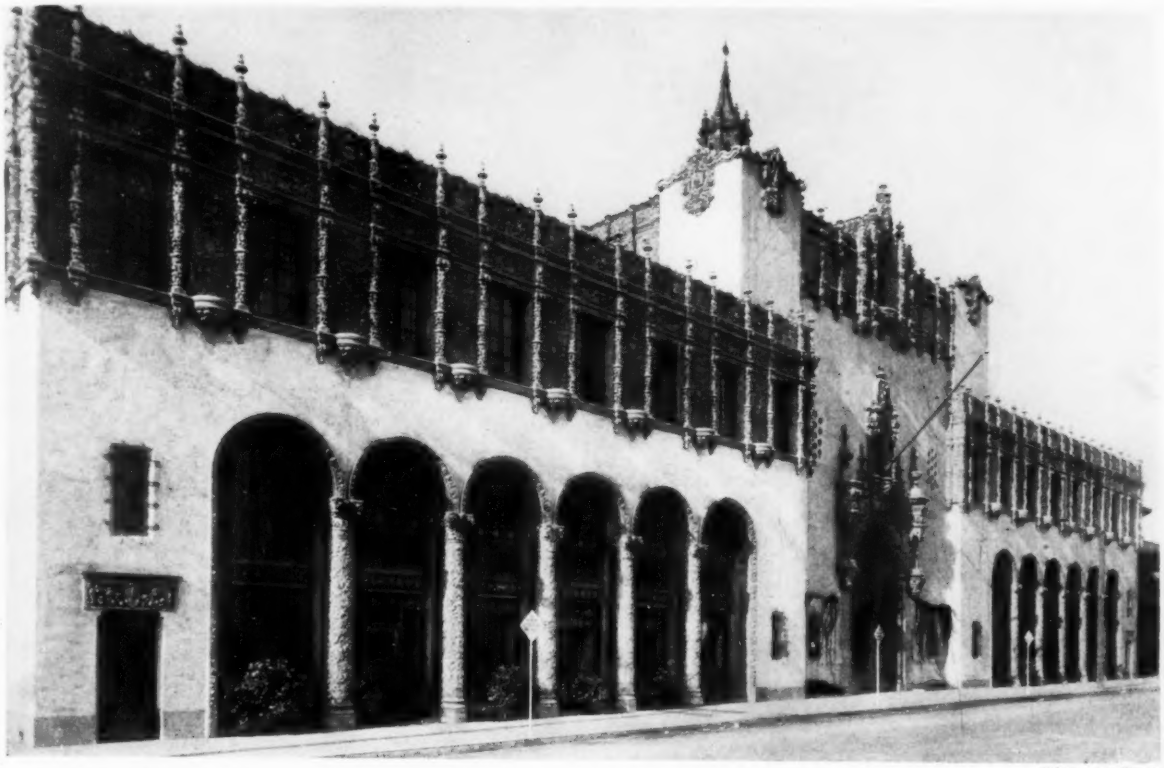
COST AND CONSTRUCTION DATA

Year of Completion: 1925.
Type of Construction: Reinforced concrete.
Exterior Materials: Plaster walls, cast stone and cement tile trim.
Interior Materials: Plaster walls.
Floors: Cement.
Windows: Steel sash.
Lighting: General illumination.
Heating: Gas steam radiators.
Cubic Foot Cost: 20 cents.
Total Cost: $348,000.
Use of Building: Warehouse.



FIRST FLOOR

PLAN. W. P. FULLER & CO. WAREHOUSE, LOS ANGELES
MORGAN, WALLS & CLEMENTS, ARCHITECTS



Plan on Back

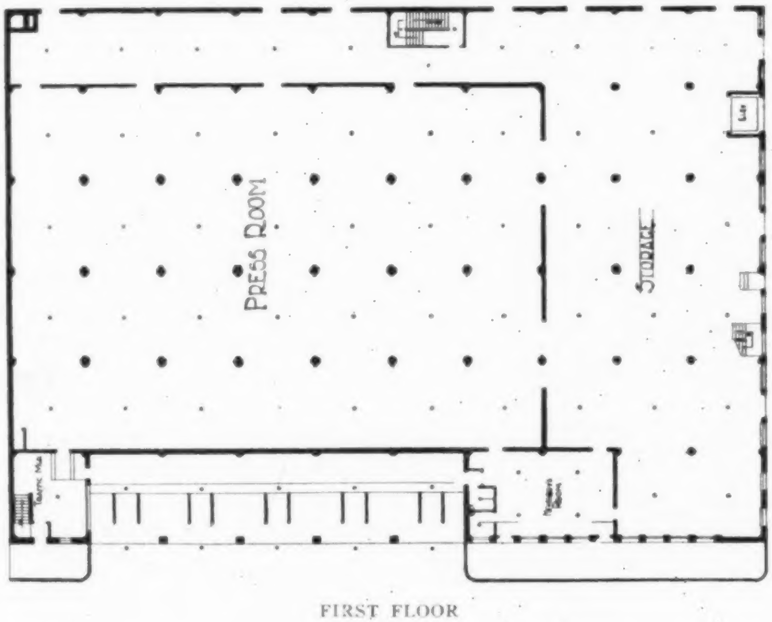
PRINTING PLANT AND OFFICES, LOS ANGELES EVENING HERALD
MORGAN, WALLS & CLEMENTS, ARCHITECTS

Photos, Mott Studios

BUILDING FOR THE HOLLYWOOD PAPER BOX CORP. AND
GENE TILDEN FURNITURE CO., LOS ANGELES
MORGAN, WALLS & CLEMENTS, ARCHITECTS

COST AND CONSTRUCTION DATA

Year of Completion: 1926.
Type of Construction: Reinforced concrete.
Exterior Materials: Plaster; cast stone trim; wrought iron grilles.
Interior Materials: Cast stone; marble; plaster.
Floors: Tile.
Windows: Wood on street front; steel elsewhere.
Lighting: General illumination with special fixtures in offices, public spaces, etc.
Heating: 2-pipe low-pressure steam.
Ventilation: Mechanical.
Cubic Foot Cost: 34 cents.
Total Cost: $768,500.
Use of Building: Newspaper printing plant.



FIRST FLOOR

PLAN. PLANT AND OFFICES, LOS ANGELES EVENING HERALD

MORGAN, WALLS & CLEMENTS, ARCHITECTS

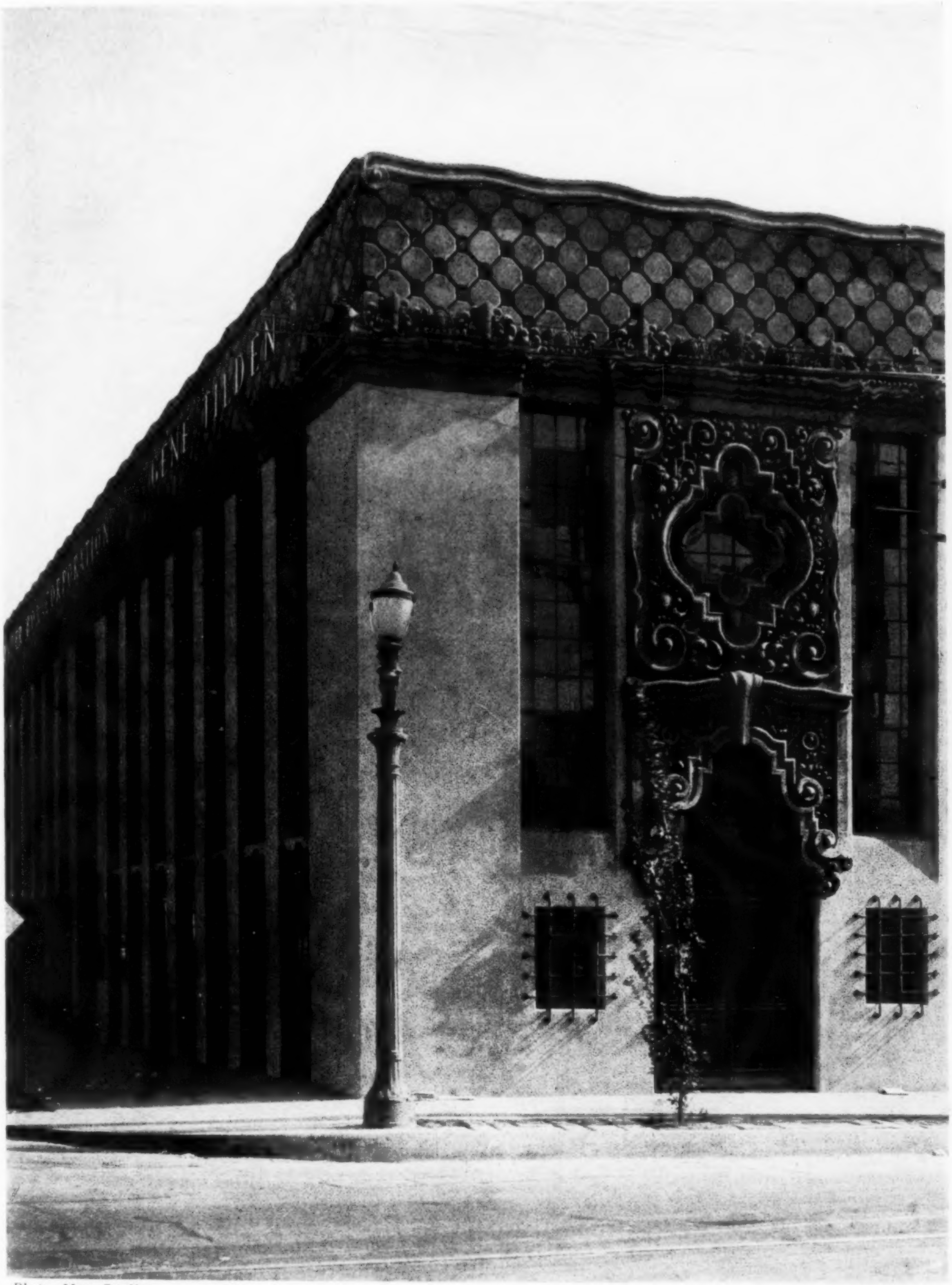


Photo. Mott Studios

SIDE ENTRANCE

BUILDING FOR THE HOLLYWOOD PAPER BOX CORP. AND GENE TILDEN FURNITURE CO., LOS ANGELES

MORGAN, WALLS & CLEMENTS, ARCHITECTS

COST AND CONSTRUCTION DATA

Year of Completion: 1925.

Type of Construction: First floor concrete; second floor frame.

Exterior Materials: Brick, plaster, cast stone trim.

Windows: Steel sash.

Lighting: General illumination.

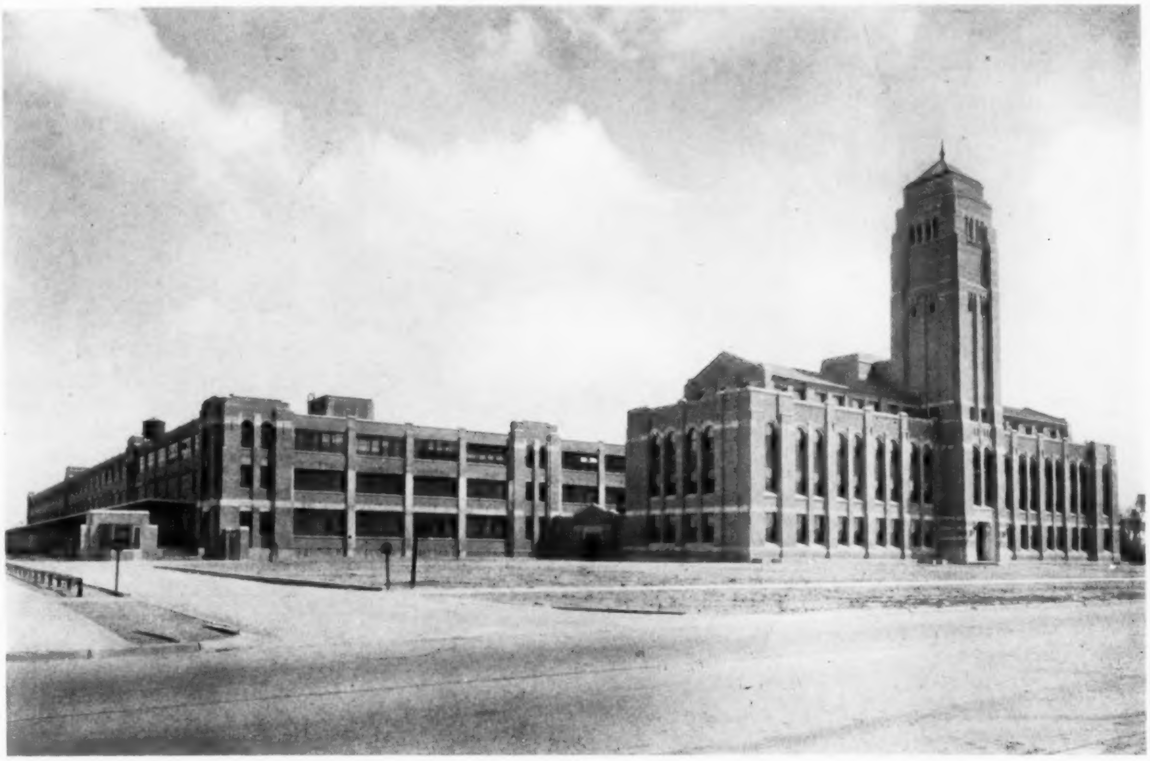
Heating: Gas steam radiators.

Total Cost: $135,360.

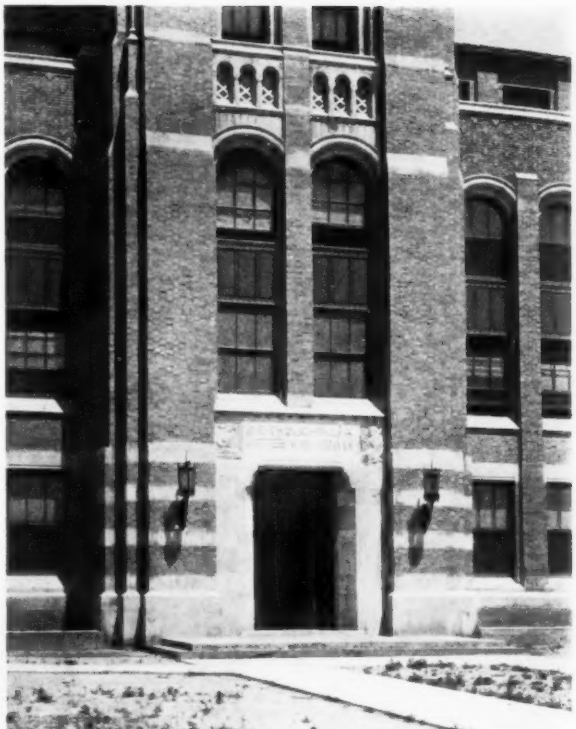
Use of Building: Manufacturing.

BUILDING FOR THE HOLLYWOOD PAPER BOX CORP. AND GENE TILDEN FURNITURE CO., LOS ANGELES

MORGAN, WALLS & CLEMENTS, ARCHITECTS



GENERAL VIEW



Photos. Thomas Ellison

FRONT ELEVATION

MAIN ENTRANCE

BUILDING FOR THE KELVINATOR CO., DETROIT

SMITH, HINCHMAN & GRYLLS, ARCHITECTS

CONSTRUCTION DATA

Type of Construction: Reinforced concrete.

Exterior Materials: Brick, artificial stone, limestone.

Interior Materials: Brick and exposed concrete; tile walls plastered in office building.

Floors: Cement.

Windows: Steel side wall sash; double-hung steel in office building.

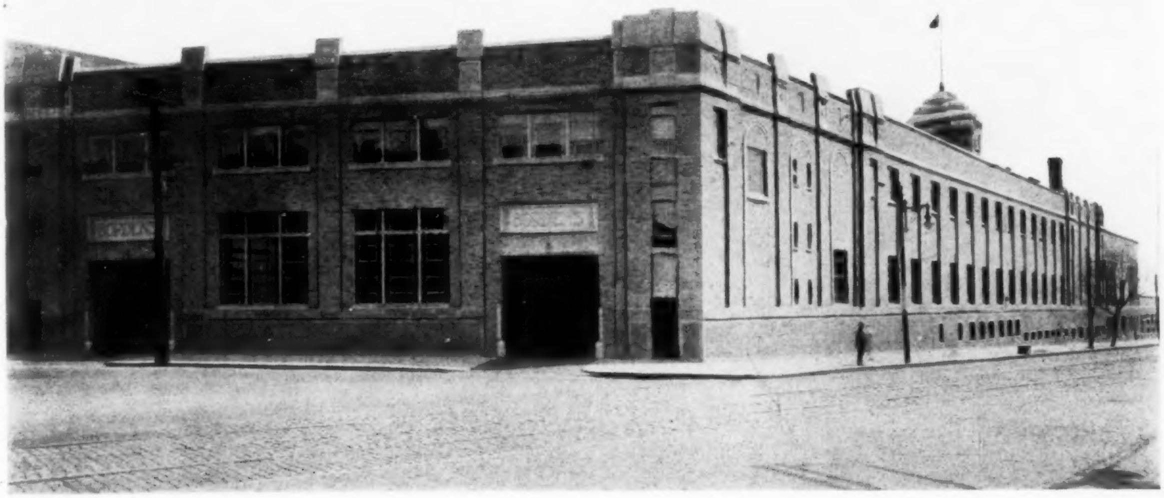
Lighting: Direct.

Heating: Direct radiation.

Use of Building: Office and factory for manufacture of electric refrigerators.

BUILDING FOR THE KELVINATOR CO., DETROIT

SMITH, HINCHMAN & GRYLLS, ARCHITECTS



END ELEVATION

Photos. Wm. F. Cone

Plan on Back

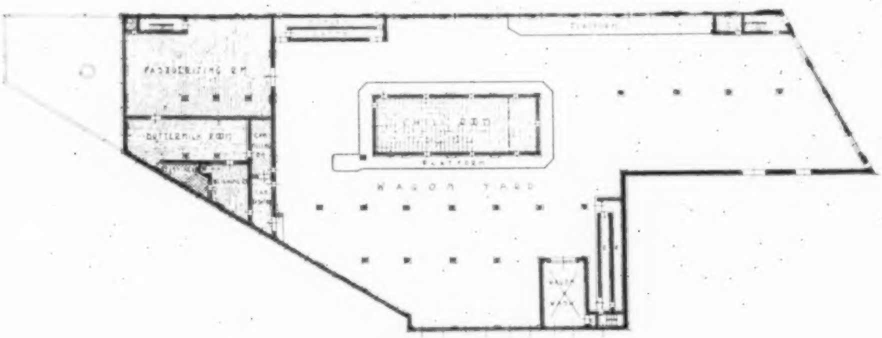
MAIN FACADE

BUILDING FOR THE BORDEN COMPANY, NEWARK

WILLIAM E. LEHMAN, ARCHITECT

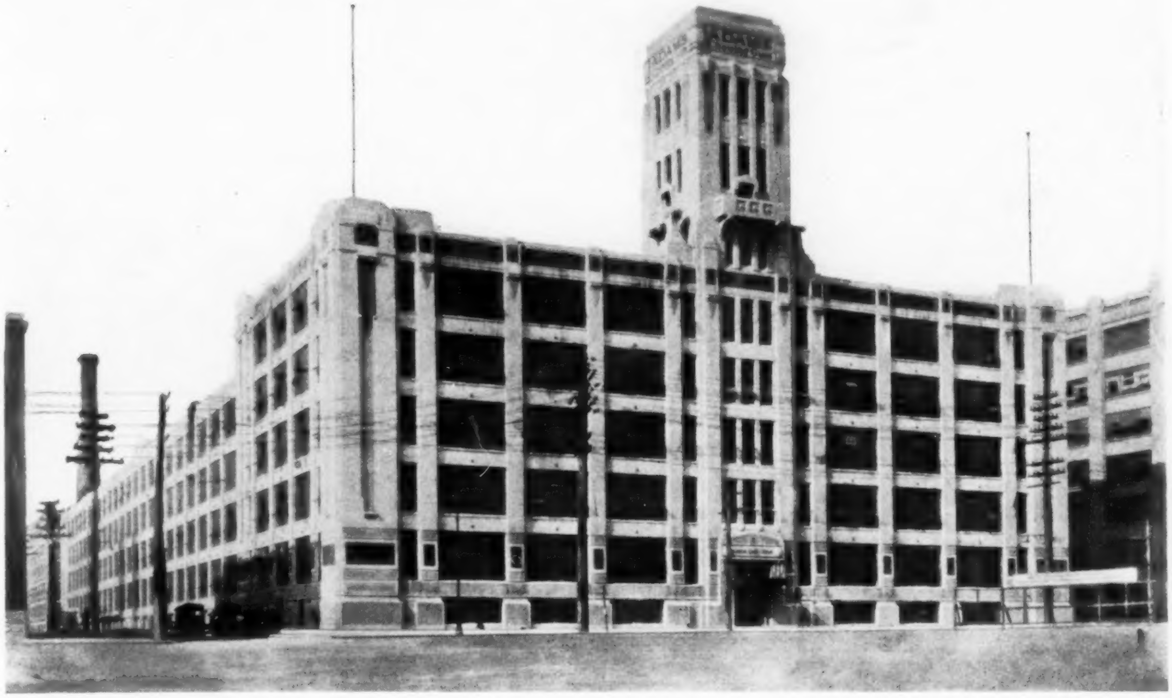
COST AND CONSTRUCTION DATA

Year of Completion: 1928.
Type of Construction: Steel and reinforced concrete.
Exterior Materials: Brick and terra cotta.
Interior Materials: Concrete and terra cotta partitions.
Floors: Concrete and tiled sidewalls.
Windows: Steel.
Lighting: Electricity.
Heating: Steam.
Ventilating: Forced draft.
Cubic Foot Cost: 50 cents.
Use of Building: Milk bottling.



FIRST FLOOR

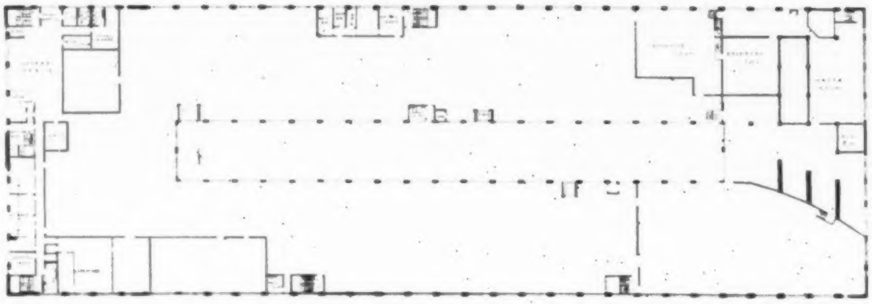
PLAN, BUILDING FOR THE BORDEN COMPANY, NEWARK
WILLIAM E. LEHMAN, ARCHITECT



Plan on Back

BUILDING FOR AMERICAN CHICLE COMPANY, LONG ISLAND CITY
THE BALLINGER COMPANY, ARCHITECTS AND ENGINEERS

BUILDING FOR INTERNATIONAL HARVESTER COMPANY, FORT WAYNE
HOLABIRD & ROOT, CONSULTING ARCHITECTS
DESIGN AND CONSTRUCTION BY DAY & ZIMMERMAN,
DIVISION OF UNITED ENGINEERS & CONSTRUCTORS, INC.



FIRST FLOOR

PLAN. BUILDING FOR AMERICAN CHICLE COMPANY, LONG ISLAND CITY
THE BALLINGER COMPANY, ARCHITECTS AND ENGINEERS

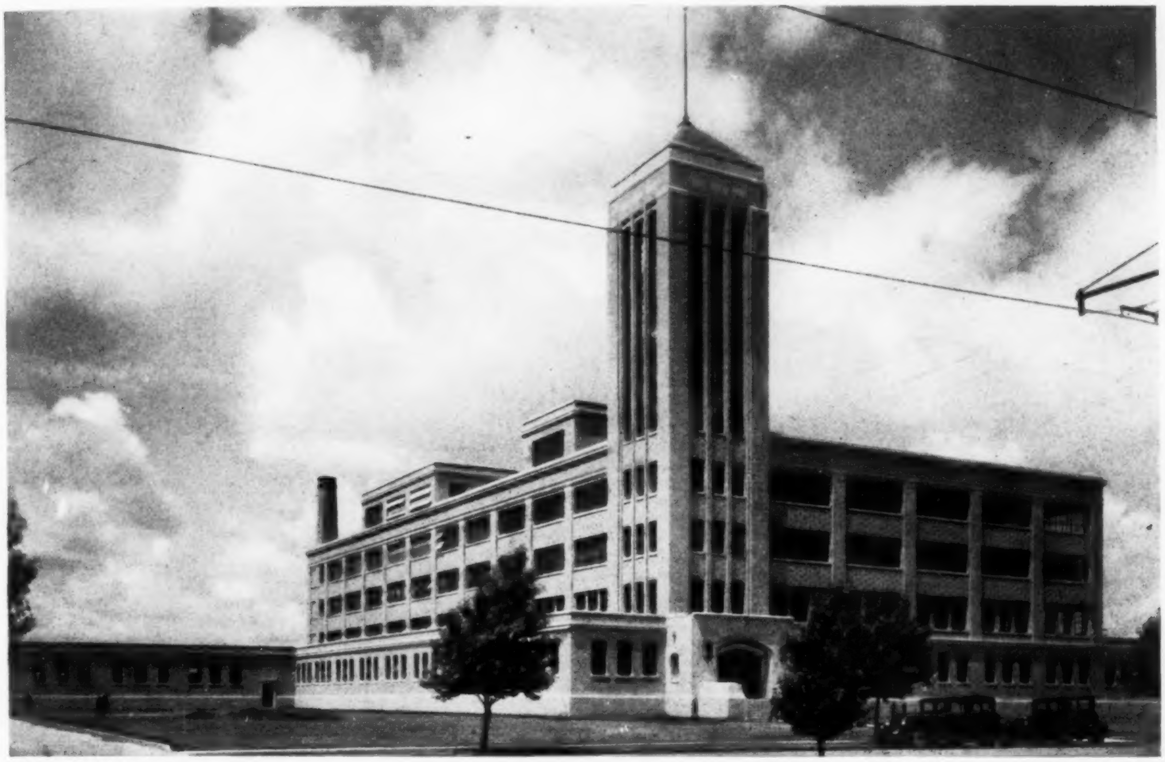


Photo. Norton & Peel

BUILDING FOR CREAM OF WHEAT COMPANY, MINNEAPOLIS
WALTER H. WHEELER, ARCHITECT AND ENGINEER

Plan on Back

BUILDING FOR MONTGOMERY WARD & CO., ST. PAUL
DESIGNED BY LOCKWOOD GREENE ENGINEERS, INC.

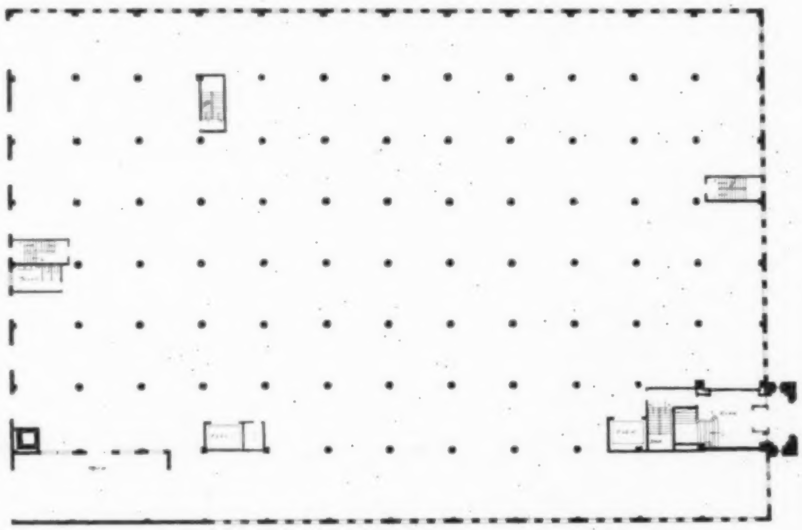
CONSTRUCTION DATA

Type of Construction: Reinforced concrete, stone front.
Exterior Materials: Rear, concrete brick; front, stone.
Interior Materials: Reinforced concrete.
Floors: Concrete.
Windows: Steel.
Lighting: Electricity.
Heating: Radiators.
Use of Building: Warehouse and office building.

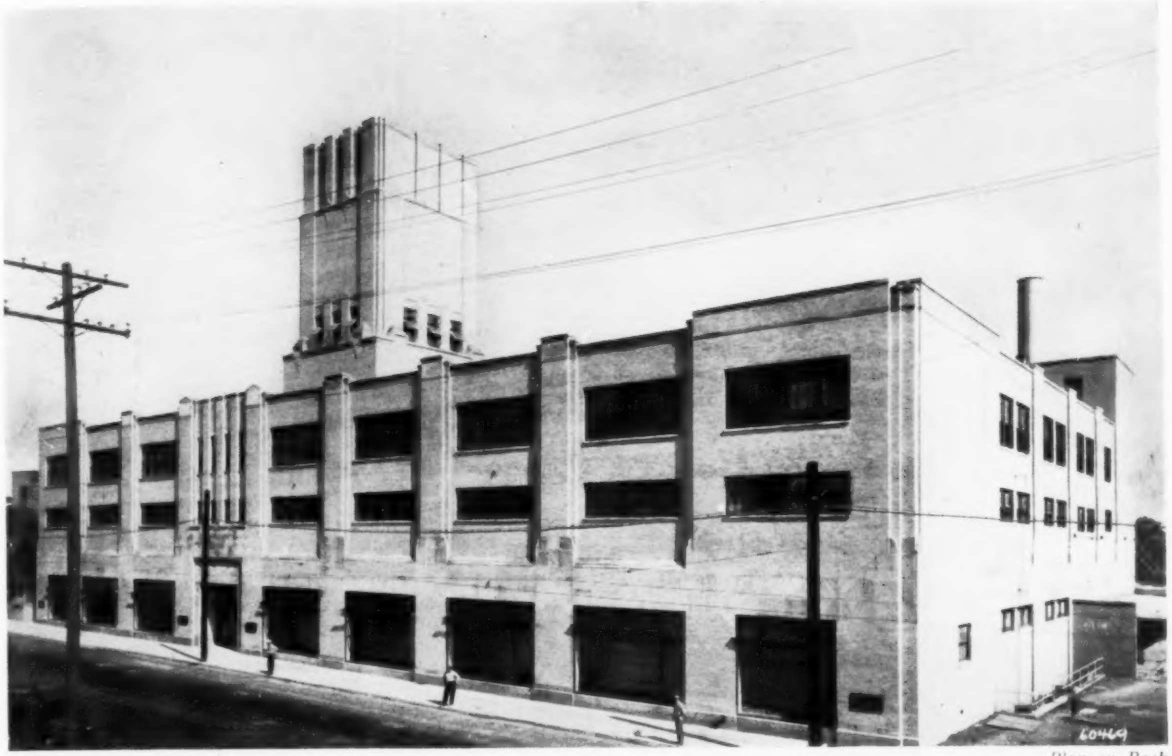
ABOVE. BUILDING FOR MONTGOMERY WARD & CO., ST. PAUL
DESIGNED BY LOCKWOOD GREENE ENGINEERS, INC.

CONSTRUCTION DATA

Type of Construction: Reinforced concrete, flat slab, fireproof.
Exterior Materials: Brick and stone.
Interior Materials: Tile partitions, brick and mahogany.
Floors: Cement finish, linoleum in general office, teak in private offices.
Windows: Steel factory sash and metal, double-hung.
Lighting: Electricity.
Heating: Vacuum, steam.
Ventilating: Indirect system.
Use of Building: Factory building and general office.

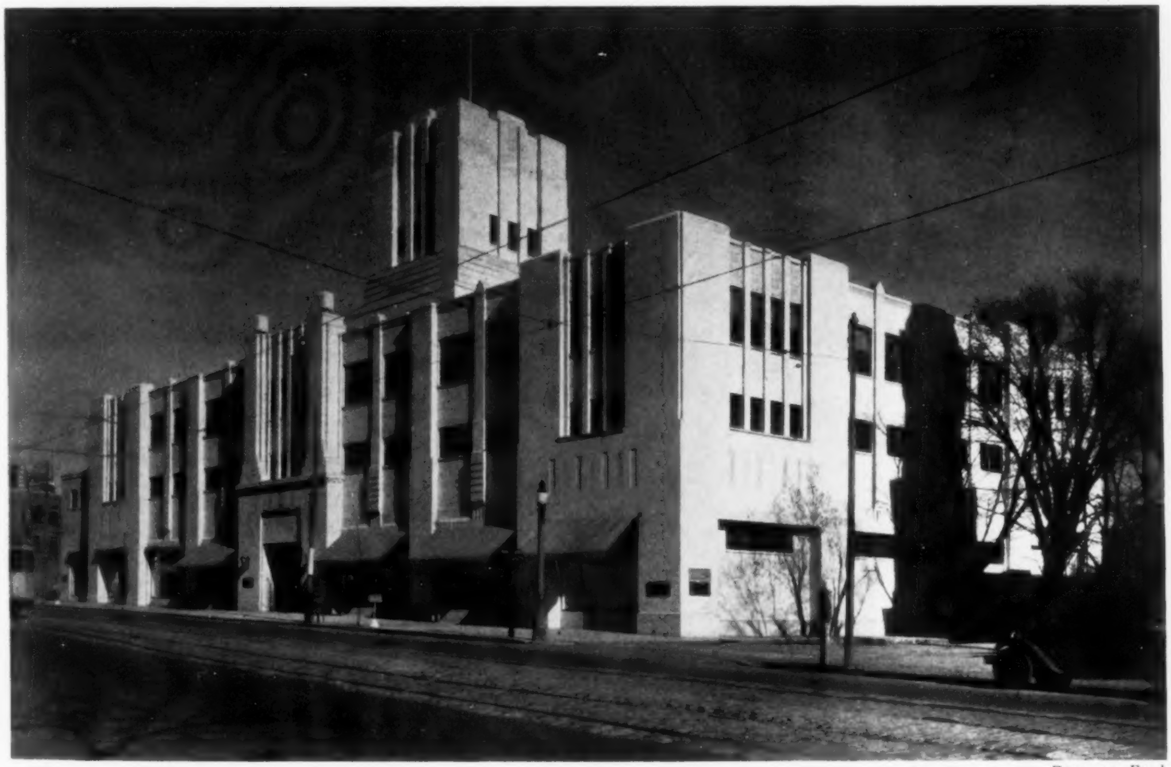


PLAN. BUILDING FOR CREAM OF WHEAT COMPANY, MINNEAPOLIS
WALTER H. WHEELER, ARCHITECT AND ENGINEER



Plan on Back

BUILDING FOR SEARS, ROEBUCK & CO., MILWAUKEE
NIMMONS, CARR & WRIGHT, ARCHITECTS

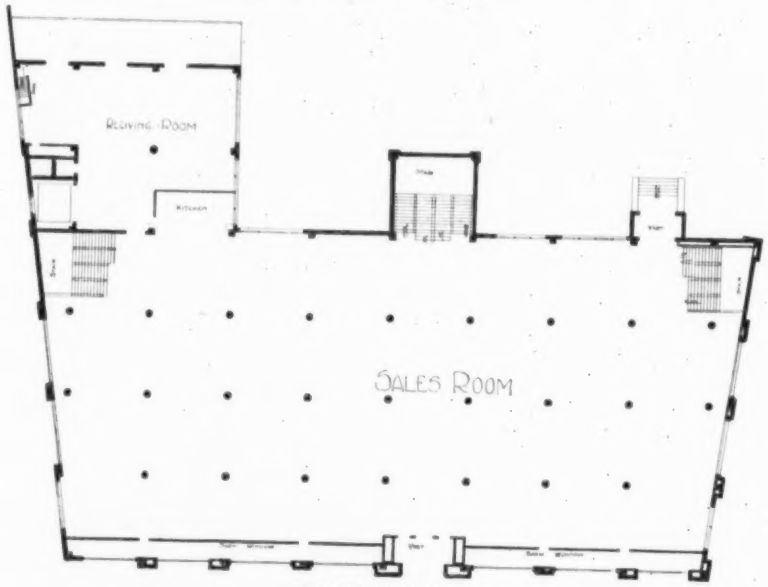


Plan on Back

BUILDING FOR SEARS, ROEBUCK & CO., CAMBRIDGE, MASS.
NIMMONS, CARR & WRIGHT, ARCHITECTS

CONSTRUCTION DATA

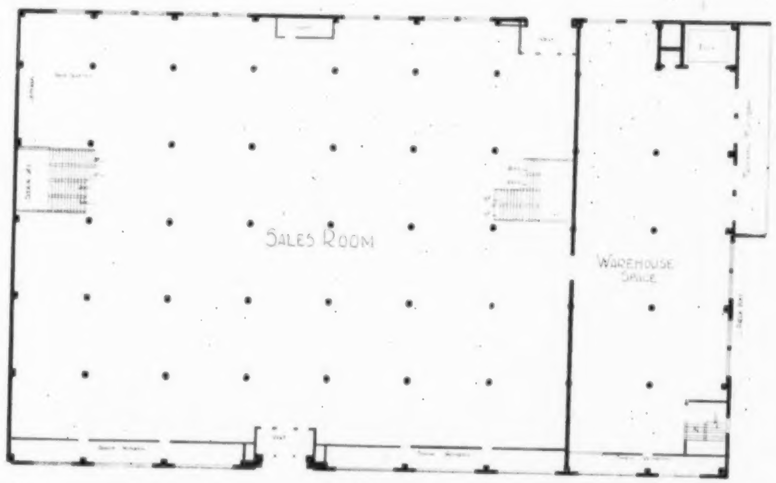
Year of Completion: 1928.
Type of Construction: Reinforced concrete, flat slab construction.
Exterior Materials: Face brick and cut stone.
Interior Materials: First and second floors, plastered walls and ceiling, wood trim, wood and metal doors; third floor, brick walls, concrete ceiling.
Floors: First and second floors, maple; basement and third floor, cement.
Windows: Steel sash.
Lighting: Semi-indirect.
Heating: Vacuum system, direct radiation throughout for heating ventilating system.
Ventilating: Fresh air and extraction.
Use of Building: Mail order store.



FIRST FLOOR
PLAN. BUILDING FOR SEARS, ROEBUCK & CO., CAMBRIDGE, MASS.
NIMMONS, CARR & WRIGHT, ARCHITECTS

CONSTRUCTION DATA

Year of Completion: 1928.
Type of Construction: Reinforced concrete, flat slab construction.
Exterior Materials: Face brick and cut stone.
Interior Materials: First and second floors, plastered walls and ceiling, wood trim, wood and metal doors; third floor, brick walls, concrete ceiling.
Floors: First and second floors, maple; basement and third floor, cement.
Windows: Steel sash.
Lighting: Semi-indirect.
Heating: Vacuum system, direct radiation throughout for heating ventilating system.
Ventilating: Fresh air and extraction.
Use of Building: Mail order store.



FIRST FLOOR
PLAN. BUILDING FOR SEARS, ROEBUCK & CO., MILWAUKEE
NIMMONS, CARR & WRIGHT, ARCHITECTS

Plan on Back

BUILDING FOR SEARS, ROEBUCK & CO., BOSTON
NIMMONS, CARR & WRIGHT, ARCHITECTS

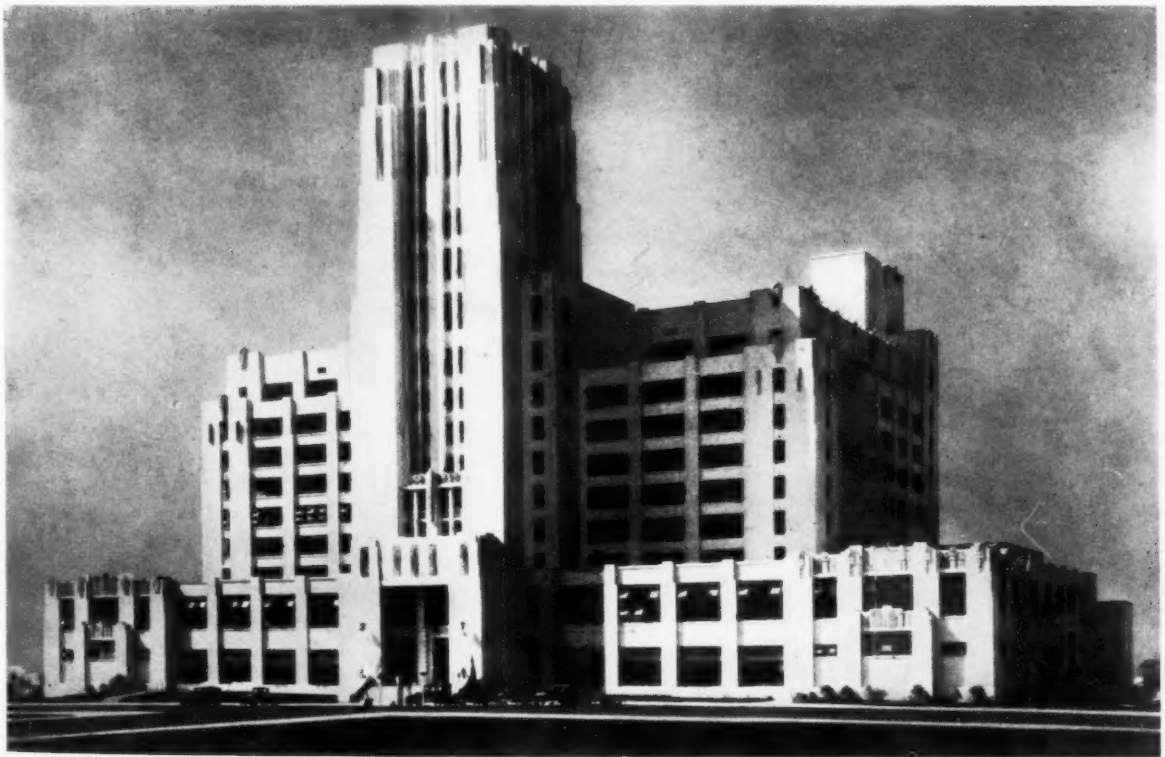


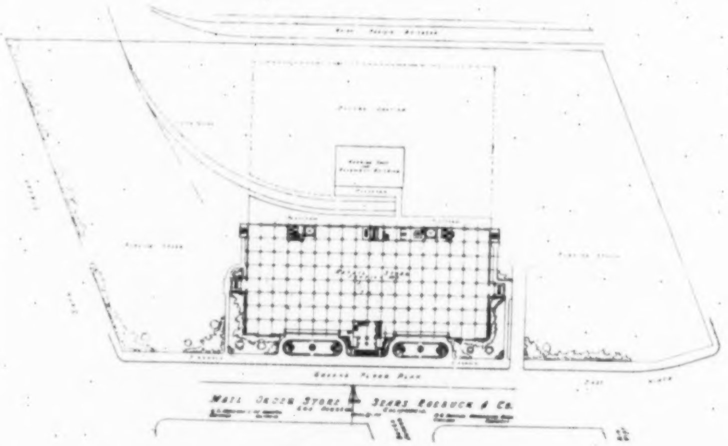
Photo. Dwyer Studio

Plan on Back

BUILDING FOR SEARS, ROEBUCK & CO., LOS ANGELES
NIMMONS, CARR & WRIGHT, ARCHITECTS

CONSTRUCTION DATA

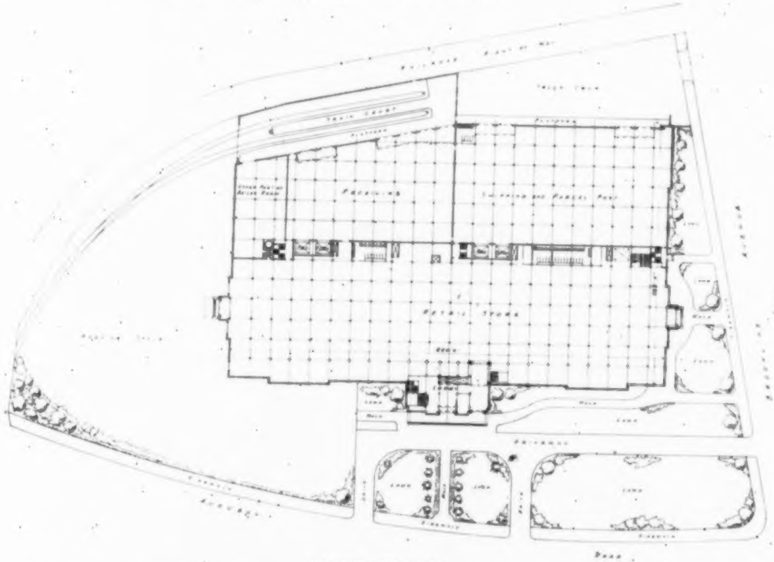
Type of Construction: Reinforced concrete, flat slab construction.
Exterior Materials: Concrete walls, stucco.
Interior Materials: First and second floors, plastered walls and ceiling; rest of building, concrete walls, wood trim, wood and metal doors.
Floors: First and second floors, maple; rest of building, wood blocks; toilet rooms, cement.
Windows: Steel sash.
Lighting: First and second floors, semi-indirect; rest of building, reflectors on drop cords.
Heating: Boiler plant, oil burners, steam- and electric-driven pumps, vacuum system.
Ventilating: Fresh air and extraction.
Use of Building: Mail order store.



FIRST FLOOR
PLAN, BUILDING FOR SEARS, ROEBUCK & CO., LOS ANGELES
NIMMONS, CARR & WRIGHT, ARCHITECTS

CONSTRUCTION DATA

Type of Construction: Reinforced concrete, flat slab construction.
Exterior Materials: Cut stone and face brick.
Interior Materials: First and second floors and tower, plastered walls and ceiling, wood trim; rest of building, brick walls, concrete ceiling, metal doors.
Floors: First and second floors and tower, maple; rest of building, cement.
Windows: Steel sash.
Lighting: First and second floors, semi-indirect; rest of building, reflectors on drop cords.
Heating: High pressure boilers, oil burning, steam driven pumps, vacuum system.
Ventilating: Fresh air and extraction; air filters in second floor.
Use of Building: Mail order store.



FIRST FLOOR
PLAN, BUILDING FOR SEARS, ROEBUCK & CO., BOSTON
NIMMONS, CARR & WRIGHT, ARCHITECTS

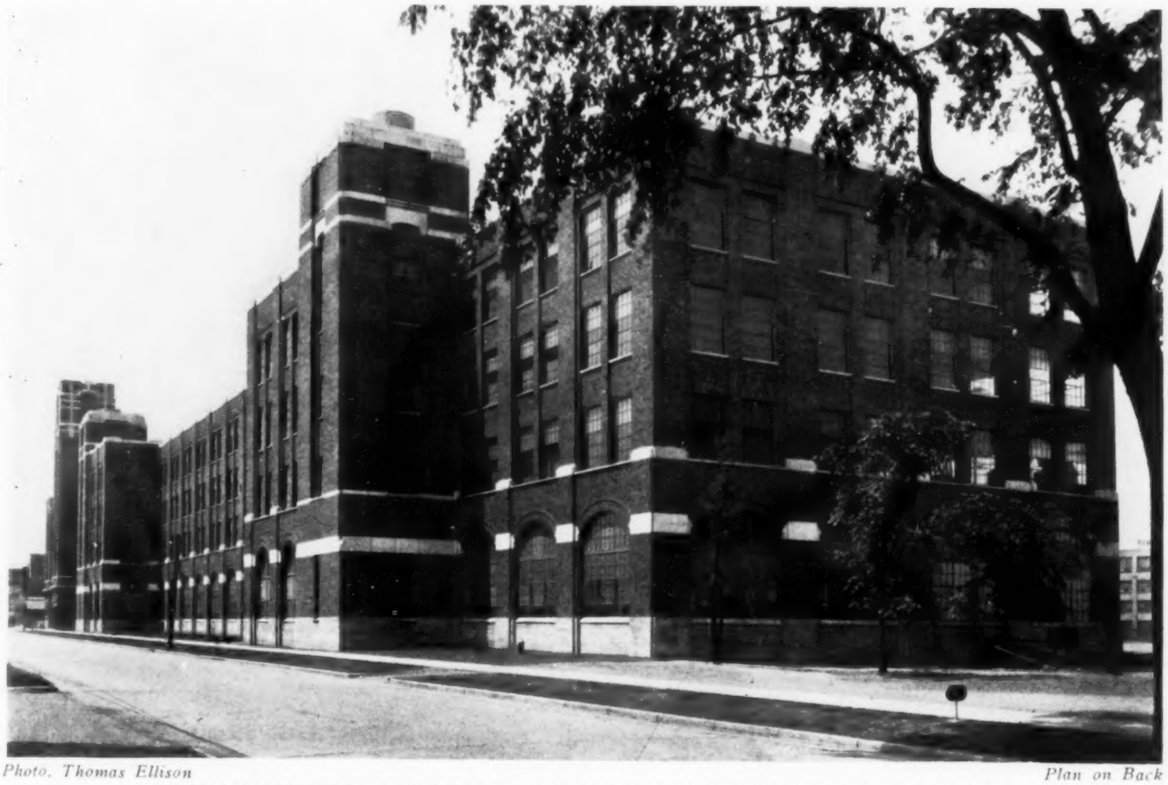


Photo. Thomas Ellison

Plan on Back

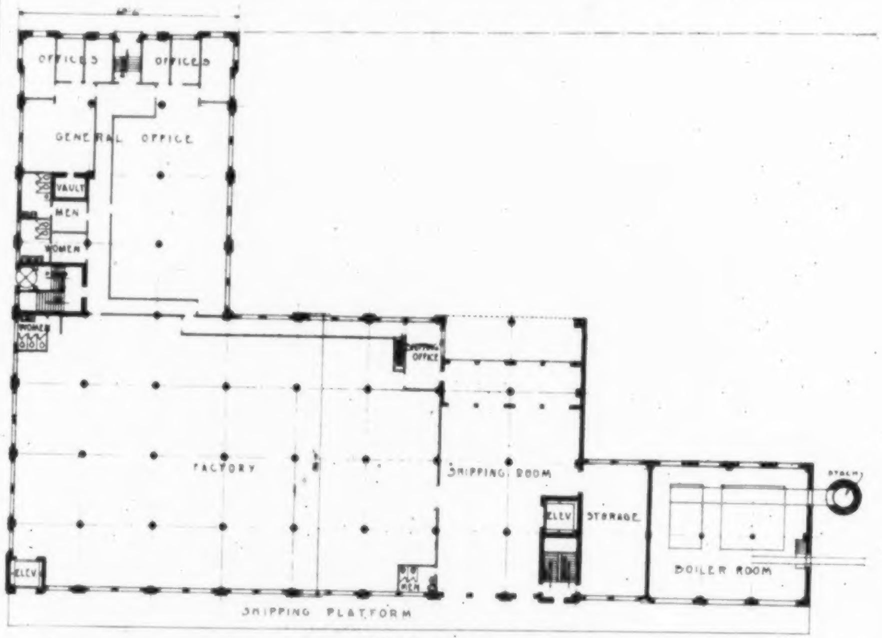
BUILDING FOR AMERICAN SEATING COMPANY, GRAND RAPIDS
SMITH, HINCHMAN & GRYLLS, ARCHITECTS

Plan on Back

BUILDING FOR WILLIAMSON CANDY COMPANY, CHICAGO
CHATTEN & HAMMOND, ARCHITECTS

CONSTRUCTION DATA

Year of Completion: 1927.
Type of Construction: Reinforced concrete.
Exterior Materials: Brick and artificial stone.
Interior Materials: Brick and exposed concrete.
Floors: First floor, creosoted wood block; other floors, cement.
Windows: Standard steel side wall sash and reversible sash, depending on location.
Lighting: Direct.
Heating: Shop section of first and second floors, unit heaters; balance direct radiation.
Use of Building: Wood working and finishing plant.



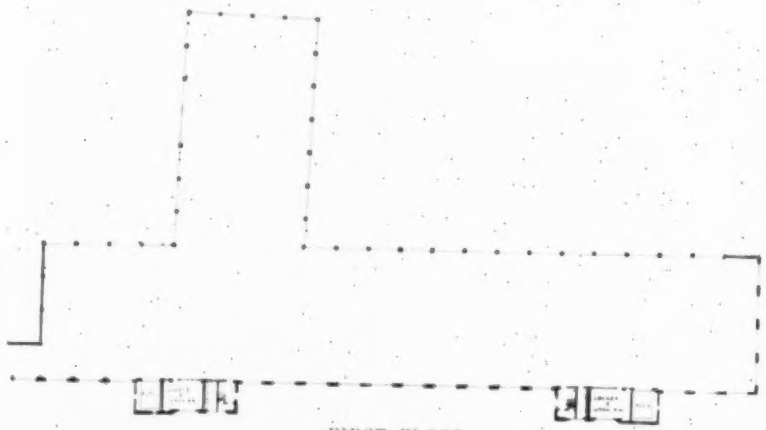
FIRST FLOOR

PLAN. BUILDING FOR WILLIAMSON CANDY CO., CHICAGO

CHATTEN & HAMMOND, ARCHITECTS

COST AND CONSTRUCTION DATA

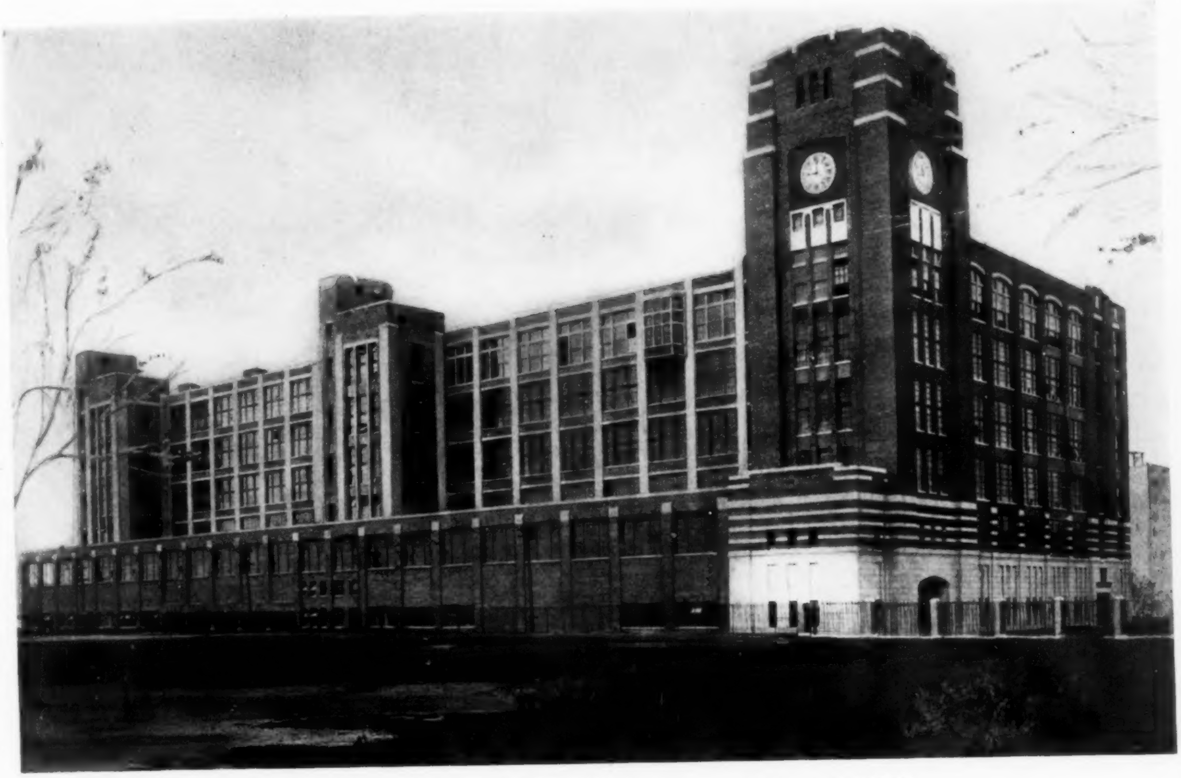
Year of Completion: 1924.
Type of Construction: Fireproof flat slab.
Exterior Materials: Face brick and terra cotta trim.
Floors: Cement.
Heating: High-pressure steam plant.
Cubic Foot Cost: 36½ cents.
Total Cost: $502,000, not including architects' fee.



FIRST FLOOR

PLAN. BUILDING FOR AMERICAN SEATING CO., GRAND RAPIDS

SMITH, HINCHMAN & GRYLLS, ARCHITECTS



BUILDING FOR W. F. SCHRAFFT & SONS, BOSTON
DESIGNED BY LOCKWOOD GREENE ENGINEERS, INC.

Photo. Manning Bros.

BUILDING FOR U. S. RUBBER CO., MORGAN & WRIGHT DIVISION, DETROIT
DESIGNED BY LOCKWOOD GREENE ENGINEERS, INC.

CONSTRUCTION DATA

Year of Completion: 1925.
Type of Construction: Reinforced concrete.
Exterior Materials: Face brick, limestone, tile.
Interior Materials: Concrete.
Floors: Concrete, wood, tile.
Windows: Steel.
Lighting: Electricity.
Heating: C I Radiator and carrier system.
Ventilating: Carrier system.
Use of Building: Candy factory.

ABOVE. BUILDING FOR W. F. SCHRAFFT & SONS, BOSTON
DESIGNED BY LOCKWOOD GREENE ENGINEERS, INC.

CONSTRUCTION DATA

Year of Completion: 1920.
Type of Construction: Reinforced concrete, brick veneer.
Exterior Materials: Face brick, art stone.
Interior Materials: Reinforced concrete.
Floors: Concrete.
Windows: Steel.
Lighting: Electricity.
Heating: C I Radiator.
Use of Building: Factory and Warehouse.

BUILDING FOR U. S. RUBBER CO.,
MORGAN & WRIGHT DIVISION, DETROIT
DESIGNED BY LOCKWOOD GREENE ENGINEERS, INC.

THE EXTERIORS OF INDUSTRIAL BUILDINGS

BY
J. P. H. PERRY
VICE-PRESIDENT, TURNER CONSTRUCTION COMPANY

INDUSTRIAL buildings in America, so far as their types of construction go, may be divided into three classes,—"mill construction," "structural steel," and "reinforced concrete." Nearly all mill construction buildings have brick walls. Structural steel industrial buildings usually have their exteriors of brick or a combination of brick and some other material such as stone, terra cotta or cast stone, though on the Pacific coast and in the southwest the current practice seems to be to occasionally use reinforced concrete exterior walls instead of brick, and there are other instances in the country where, perhaps to break a bricklayers' strike, concrete has been used for the walls. Reinforced concrete industrial buildings have their exterior walls usually of four types: (a) all concrete, (b) all brick, (c) all terra cotta or stone, (d) a combination of concrete and brick, stone, terra cotta or cast stone.

The architectural treatment of the exteriors of industrial buildings of the mill construction or the structural steel type of construction is generally studied from a point of view not materially dissimilar to that in mind when commercial buildings are being designed. On the other hand, the problem of how to treat the walls of a reinforced concrete factory or warehouse has not yet been solved to a point where there has been any general adoption of a standard method. It was only a little over 30 years ago that the first reinforced concrete industrial building was built in America,—the Pacific Coast Borax Company's four-story factory at Bayonne. Hardly a generation thus has passed since that pioneer structure was erected, and yet today we find reinforced concrete very generally accepted as the leading structural material for industrial buildings. While the merit of reinforced concrete as a structural material is fully admitted, it is a fact that in the minds of many architects the term "concrete building" brings up a picture of concrete exterior walls. In many instances the inappropriateness of such exterior treatment eliminates the concrete type from further consideration, and fireproofed steel is adopted as a structural material, whereas money would have been saved and at least an equally good if not a better building would have been designed had reinforced concrete been used for the skeleton frame, and the problem of how to design the exterior approached in a manner identical to that which would have prevailed had steel or even mill construction been adopted. The architect would often save real money for his client and gain many advantages for his building if he could establish in his mind clearly the absolute interchangeability of the terms "structural steel" and "structural concrete." There are thousands of fine factories and warehouses with brick, terra cotta or cast stone exterior walls whose skeleton frames and interior construction are of reinforced concrete. These buildings are just as truly "concrete buildings" as though they had been given concrete exterior treatment.

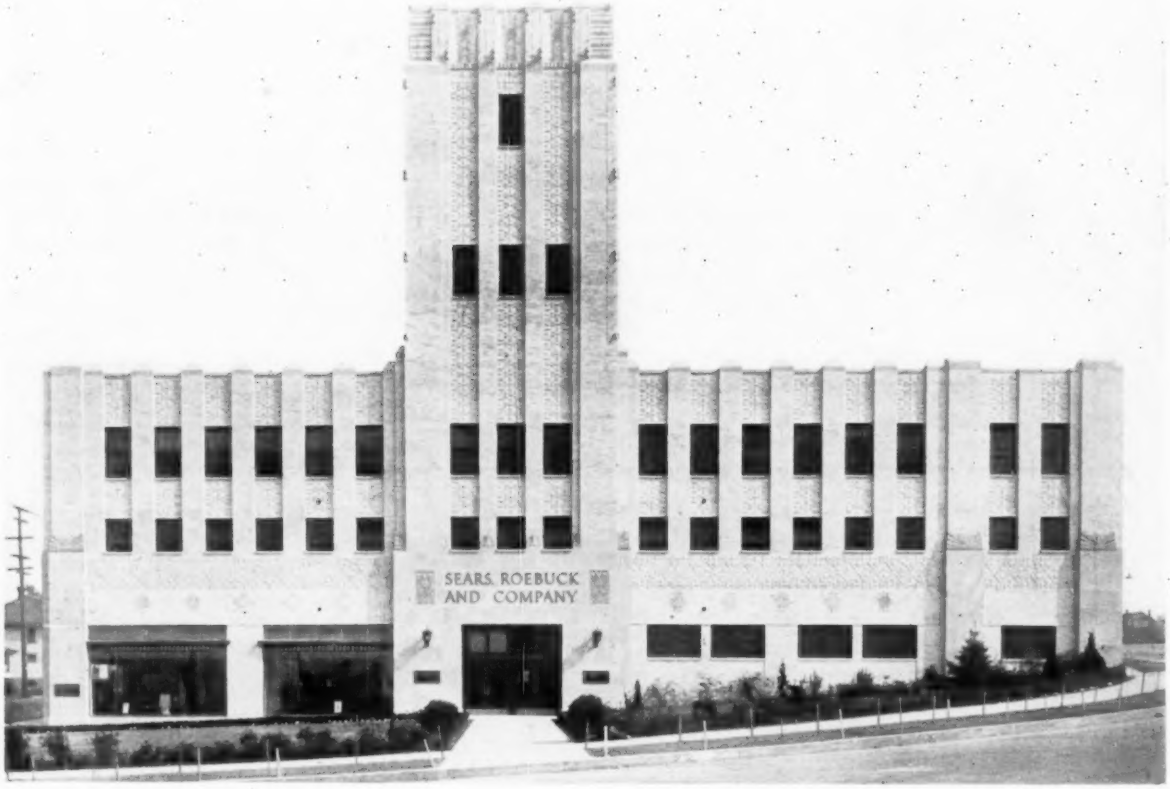
It will probably be generally granted that the exteriors of the early all-concrete factories or warehouses were not very pleasing, and no argument would be made with the statement that their concrete walls, so far as appearance goes, have not worn very well. Some of the present unsightliness of the early buildings can be accounted for by faults of design and construction which are now eliminated in well built concrete structures. In very early buildings reinforcing rods were placed too close to the surface, with consequent rusting of the reinforcement followed by spalling of the concrete. Form work has been greatly improved in the last 25 years. Methods of treating concrete surfaces are now not only better understood but more dependable. The early designers using concrete failed to regard the new material as worthy of original treatment. Instead, every effort was used to make concrete resemble stone by using heavy rustication or quoin markings. Some of the modern concrete buildings, such for example as the splendid mail order houses of Sears, Roebuck & Company and structures such as Cass Gilbert's Army Base, point the way to the successful handling of concrete as concrete and concrete alone. The modern set-back architecture and the massing on vertical lines create an opportunity for use of concrete that it never previously enjoyed.

In spite of great improvements in design and construction of concrete exterior walls, the fact cannot be ignored that, in the east and central part of the country at least, the trend of the best architectural practice for industrial buildings is not to use concrete alone for the exterior walls. Most of the better buildings erected during the last six or eight years have been either of all brick or of brick with a combination of cast stone or terra cotta, or of a combination of brick with exposed concrete columns, or of brick with exposed concrete columns and floor beams. To verify this statement, I asked our statistical de-

Photo. Philip B. Wallace

BUILDING FOR SEARS, ROEBUCK & COMPANY, PHILADELPHIA

NIMMONS, CARR & WRIGHT, ARCHITECTS

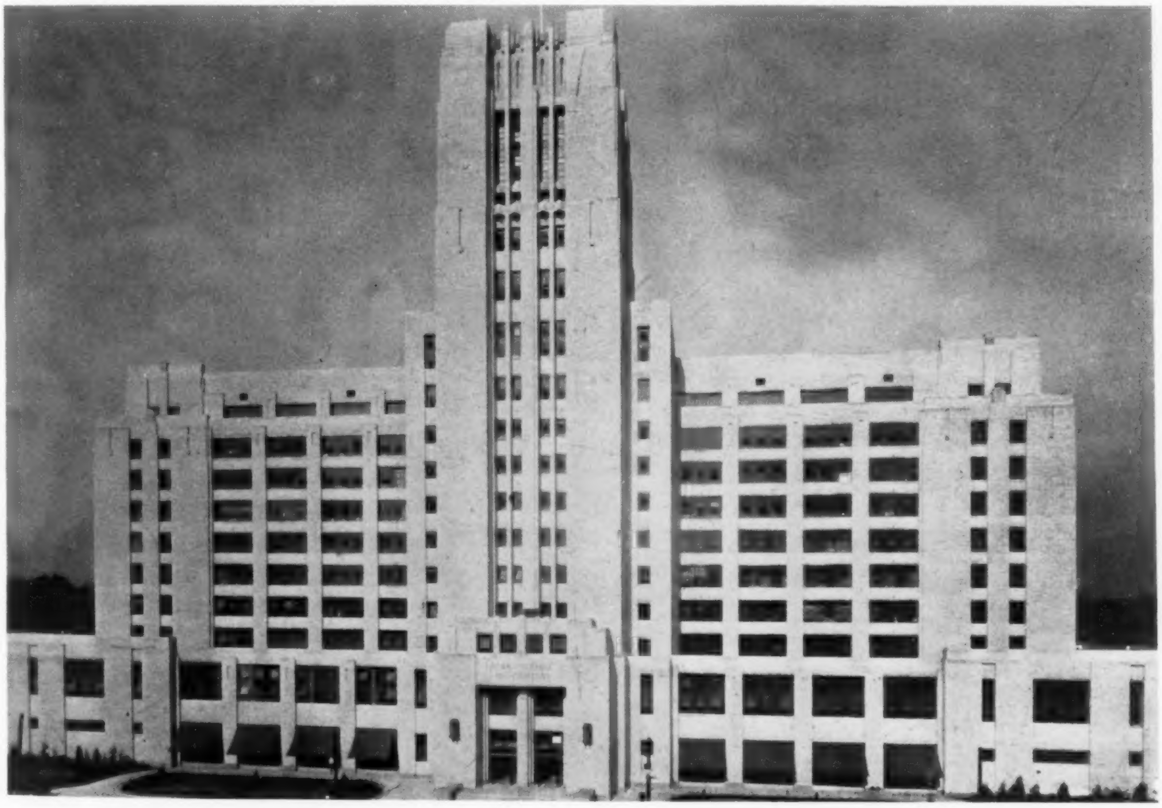


BUILDING FOR SEARS, ROEBUCK & COMPANY, PORTLAND, ORE.

NIMMONS, CARR & WRIGHT, ARCHITECTS

Photo. Nordin Studio

BUILDING FOR SEARS, ROEBUCK & COMPANY, MINNEAPOLIS
NIMMONS, CARR & WRIGHT, ARCHITECTS



BUILDING FOR SEARS, ROEBUCK & COMPANY, MEMPHIS
NIMMONS, CARR & WRIGHT, ARCHITECTS

Courtesy of Turner Construction Co.

BUILDING FOR AMERICAN CAN COMPANY, BROOKLYN
CARL PREIS, ARCHITECT

Courtesy of Turner Construction Co.

WAREHOUSE FOR BLOOMINGDALE BROTHERS, LONG ISLAND CITY, N. Y.
ABBOTT, MERKT & COMPANY, ARCHITECTS

Photo. Tebbs & Knell, Inc. Courtesy of Turner Construction Co.

BUILDING FOR HEARST PUBLICATIONS, NEW YORK

CHARLES E. BIRGE, ARCHITECT

Courtesy of Turner Construction Co.

BUILDING FOR GENERAL ELECTRIC COMPANY, WEST PHILADELPHIA

HARRIS & RICHARDS, ARCHITECTS

Photo. Mott Studios

SUB-STATION, SOUTHERN CALIFORNIA EDISON COMPANY

HUNT & BURNS, ARCHITECTS

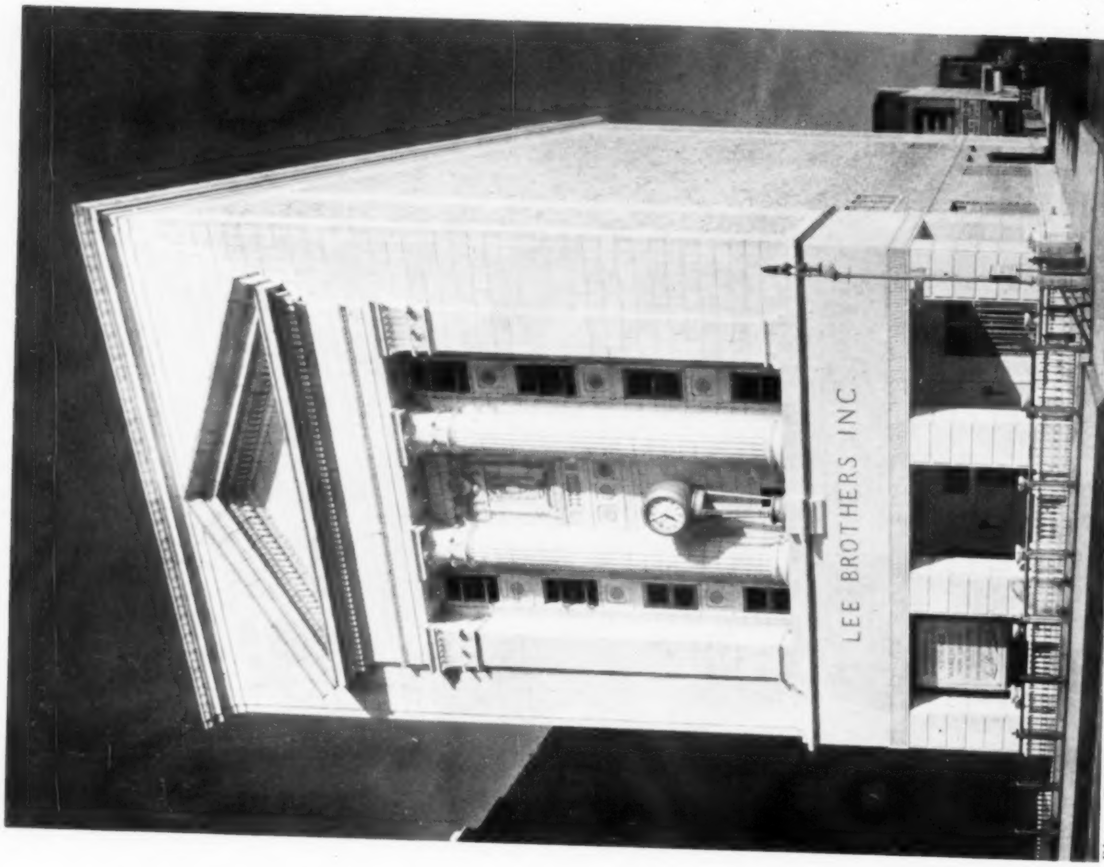


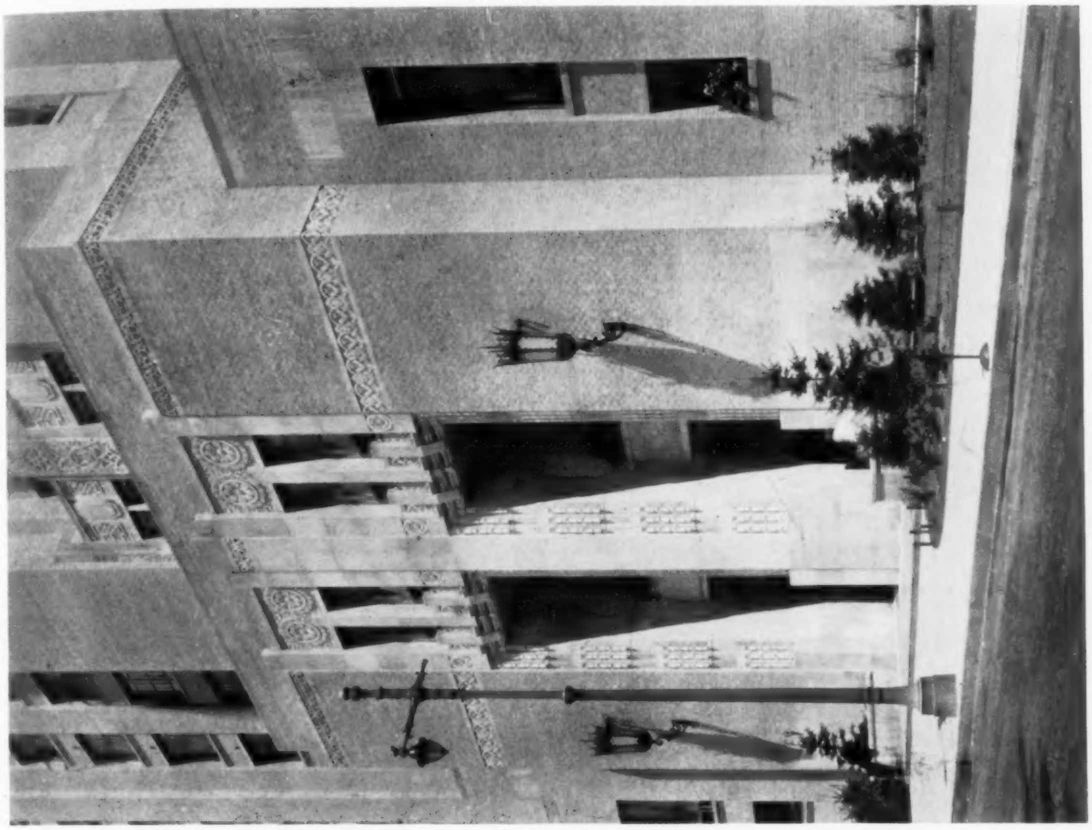
Photo. Tebbs & Knell, Inc. Courtesy of Turner Construction Co.

WAREHOUSE FOR LEE BROTHERS, INC., NEW YORK

KINGSLEY SERVICE, INC., ARCHITECTS

Photo, Mott Studios

MAIN ENTRANCE
HOLLYWOOD STORAGE WAREHOUSE, LOS ANGELES
MORGAN, WALLS & CLEMENTS, ARCHITECTS



MAIN ENTRANCE
BUILDING FOR SEARS, ROEBUCK & COMPANY, MINNEAPOLIS
NIMMONS, CARR & WRIGHT, ARCHITECTS

Photo. Mott Studios
AMERICAN STORAGE WAREHOUSE, LOS ANGELES
ARTHUR E. HARVEY, ARCHITECT

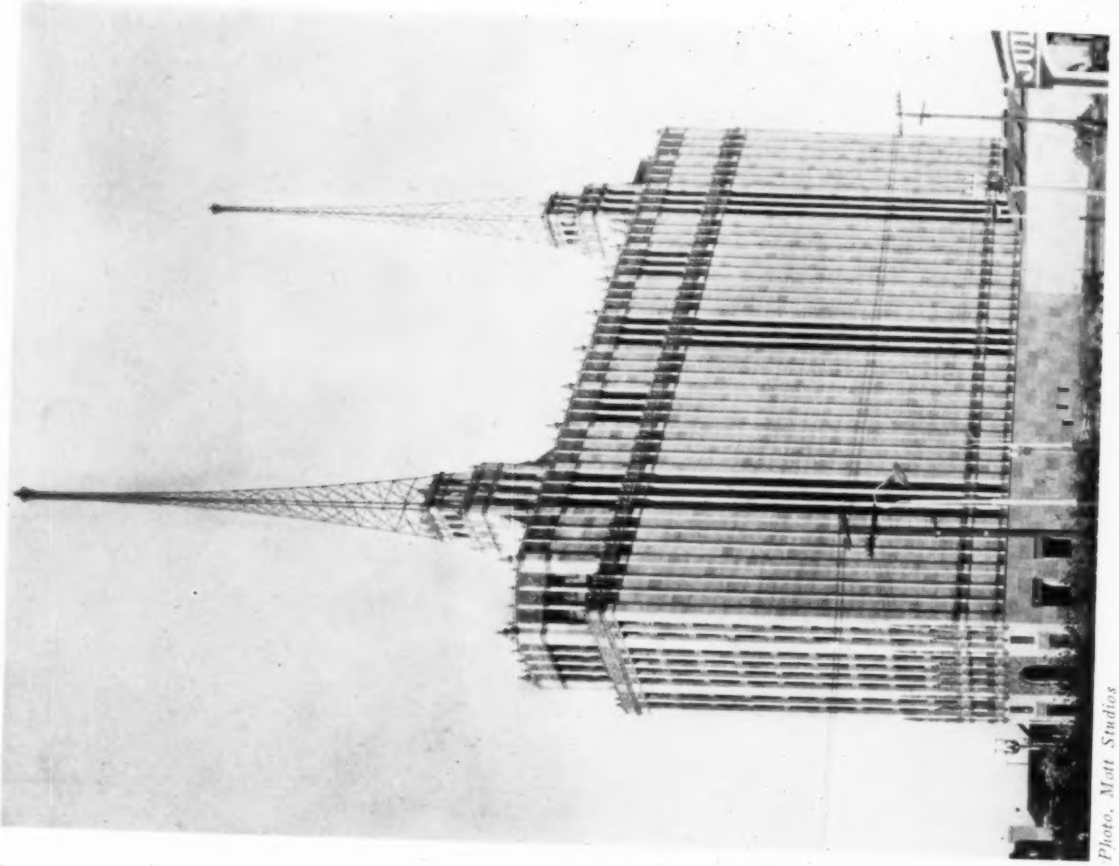


Photo. Mott Studios
HOLLYWOOD STORAGE WAREHOUSE, LOS ANGELES
MORGAN, WALLS & CLEMENTS, ARCHITECTS

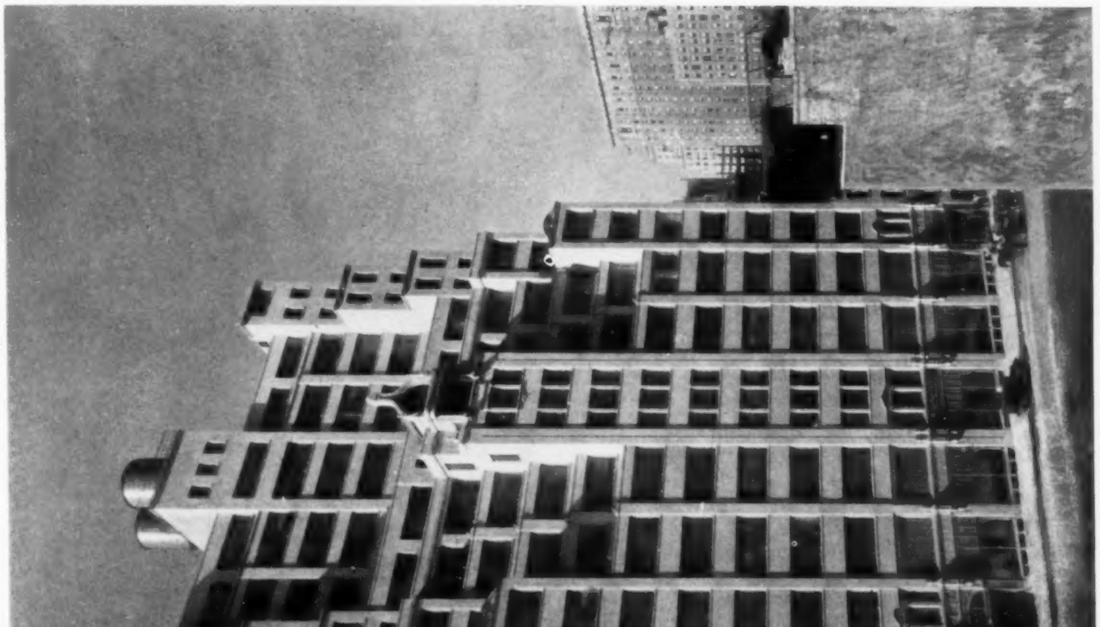


Photo. Tebbs & Knell, Inc. *Courtesy of Turner Construction Co.*

LOFT BUILDING ON EAST FORTY-FIFTH STREET, NEW YORK

OTTO STRACK, ARCHITECT

Courtesy of Turner Construction Co.

BUILDING FOR F. G. SHATTUCK COMPANY, NEW YORK

RUSSELL G. CORY, ARCHITECT

Photo. Tebbs & Knell, Inc. *Courtesy of Turner Construction Co.*

GREEN TERMINAL BUILDING, NEW YORK

RENWICK, ASPINWALL & GUARD, ARCHITECTS

Courtesy of Turner Construction Co.

BUILDING FOR AMERICAN NEWS COMPANY, NEW YORK

RUSSELL G. CORY, ARCHITECT

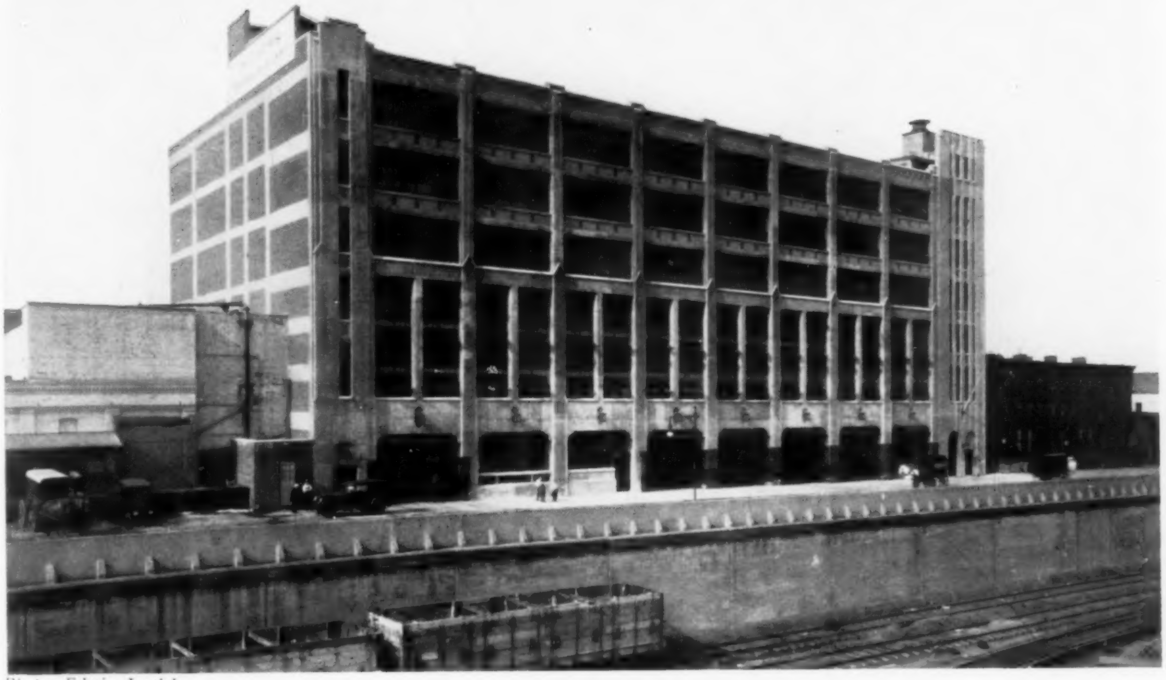


Photo. Edwin Levick

Daily News Building, Brooklyn
Designed by Lockwood Greene Engineers, Inc.

partment to make a study of 1,015 industrial buildings built by our Company during the past 27½ years. During the first 16 years (prior to 1918) 57 per cent of these factories and warehouses had their walls of all concrete. From 1918 to 1923, inclusive, 43 per cent of such buildings had their exteriors of all concrete, and in the six years from 1924 to 1929, inclusive, only 30 per cent of such structures had all-concrete exteriors. A further indication that the all-concrete exterior is not as generally used as it used to be is found by studying the work of such leading industrial architects as Nimmons, Carr & Wright, A. S. Alschuler, and S. Scott Joy in Chicago; Albert Kahn in Detroit; Monks & Johnson in Boston; Lockwood, Greene & Company, Frank S. Parker, Buchman & Kahn, and Russell G. Cory in New York. Such a study will indicate that the majority of their buildings have their exteriors rarely all of concrete. A further indication of this trend is seen in the designs adopted by some of the great industrial concerns of America. Among others there may be mentioned: The General Electric Company; Sears, Roebuck & Company; Western Electric Company; Ford Motor Company; National Biscuit Company; American Telephone & Telegraph Company and its many subsidiaries; Packard Motor Car Company,—in fact the automobile industry in general has swung away from the use of the all-concrete exterior for its great manufacturing plants scattered over the country.

In Chicago, where concrete is used for building construction probably as widely if not more so than in any city in the country, it is very rarely that one sees an all-concrete exterior. The Central Manufacturing District, containing one of the finest groups of industrial buildings in America, has adopted a very pleasing exterior treatment of brick with ornament of terra cotta or stone. Perhaps the only locality where the all-concrete exterior is not declining in popularity is in the southwest, and particularly in California, where buildings with concrete walls are being increasingly built and very satisfactorily so,—as is evidenced by such outstanding structures as Sears, Roebuck & Company's mail order house in Los Angeles; Montgomery Ward & Company's great buildings in Fort Worth and in Oakland; and the Hollywood Terminal and the American Storage Buildings in Los Angeles, illustrated in this issue of The Forum.

The fundamental reason for getting away from use of all-concrete exteriors is not hard to find. In general, the primary excuse for using concrete exteriors is economy, plus the readiness with which it lends itself to being moulded in special forms and its inherent expression of sturdy strength for massive design. Industrial America has been growing richer and richer, and the

Warehouse for Montgomery, Ward & Company, Fort Worth, Texas
W. H. McCaully, Architect

American industrial executive has reached the point where he can afford to pay for what he wants. Architects, engineers and contractors have learned that brick, stone and terra cotta or combinations thereof produce a more pleasing appearance and preserve a distinguished character over a period of years much more dependably than any known type of concrete construction has yet done. The same tendency toward securing better looking buildings is seen in commercial structures all over the country,—structures such as hotels, apartment houses, office buildings, schools, bank buildings and the like. When concrete was in its infancy, such commercial structures were built largely of brick, whereas now we see limestone, terra cotta, cast stone, fine face bricks, granite, and even marble being increasingly used.

All the foregoing, however, should not be taken as meaning that the factory or warehouse with the all-concrete exterior or a combination of concrete with some other material has not still and probably always will have a substantial place in industrial building design. There are many notable examples,—some of them illustrated here,—which are extremely pleasing in design and equally satisfactory in construction. There are factories and warehouses of great magnitude built with all-concrete exteriors, such as the huge mail order houses of Montgomery Ward & Company in Albany and Baltimore; the plants of the American Can Company scattered over the country; the amazing number of fine concrete buildings in the Holland Tunnel section of New York, in Jersey City and Newark, and in Long Island City, to say nothing of the great buildings in Texas and up and down the Pacific coast. In the experience of our Company, however, certainly during the past six or eight years, we find that for every factory or warehouse with an all-concrete exterior we get a building where brick spandrel walls are used and the concrete skeleton left exposed. Some notable examples of this method of exterior treatment are the Schrafft candy factory in Charlestown, Mass.; Bloomingdale Brothers' large warehouse in Long Island City; the two 700-foot buildings of the General Electric Company at their new West Philadelphia plant; the tremendous new terminal warehouse of the D. L. & W. Railroad in Hoboken, as well as the buildings of the Great Atlantic & Pacific Tea Company and the splendid development of the American Woolen Company in Shawsheen, Mass.

If an architect selects or his client requests an all-concrete exterior treatment, there are several fairly standardized surface treatments open to his choice such as: (a) Leaving the concrete surface substantially untouched as it comes from the forms except for pointing and the correction

Warehouse for Montgomery, Ward & Company, Baltimore
W. H. McCaully, Architect

of column and beam lines and dressing of fill lines, etc. (b) Rubbing a cement grout on the surface with a float or a carborundum brick. (c) Roughing the surfaces to expose the aggregate, either by tooling or by the use of a proprietary grease painted on the forms. (d) Painting the surfaces with a proprietary coating, either colorless or to similate the color of concrete or with colored pigments to produce any shade of color desired. (e) Stuccoing with either a thin coat or a regular two-coat process. Probably the most generally adopted of these methods are the rubbing in of cement grout with a carborundum brick or the painting of the exterior and, finally, the use of stucco. The majority of the fine concrete buildings in the southwest and in California,—those of most pleasing appearance,—have a thin stucco put on the concrete. Monolithic ornamentation can be added by the use of plaster moulds. A notable example of this method of treatment is shown in the detail of the Hollywood Terminal Building on page 319. The Sears, Roebuck & Company mail order house in Los Angeles is similarly treated. Montgomery Ward & Company's mail order houses in the southwest have their all-concrete exteriors painted.

Recently there has been a distinct step forward in an effort to produce finer concrete exteriors by the lining of the forms with composition or presswood sheets or with heavy linoleum types of paper which have been produced now on a practical basis so that they do not curl when the wet concrete comes against them, are heavy enough to stand the wear and tear of construction, and are also cheap enough to still keep the cost of the concrete well below that of brick. A notable example of the successful use of this method is the new mail order house of Montgomery Ward & Company in Albany.

There is a distinct trend toward the use of colored tile inserts to relieve the monotony of an all - concrete exterior. The American News Building in New York is an example of this treatment, and the Lasher Printing Company's building in Philadelphia with its use of brick ornamentation points the way to an interesting possibility in treating all-concrete exteriors. The splendid building housing the Hearst publications on South Street, New York, designed by Charles E. Birge, is an interesting example of an all-

Photo. Camera Craft Studio

Building for Geo. F. Lasher Printing Company, Philadelphia

Philip S. Tyre, Architect

concrete plain exterior of simple proportions and extremely fine workmanship, producing even, true surfaces with the use of decorative panels on the parapet. The Fuller warehouse in Los Angeles is an extremely interesting example of the all-concrete building. A more conservative treatment has been adopted by the American Can Company in a number of its great plants, as witness the large factory in South Brooklyn. An unusual design was adopted by E. R. Squibb & Son for their factory in Brooklyn. A typical treatment of the concrete loft building is shown in the Green Terminal Building in the Holland Tunnel section of New York. Where large concrete structures have been built in Manhattan, the majority of them have brick exteriors, as witness the Publishers' Building on West 52nd Street, the Cadillac Building on Columbus Avenue at 63rd Street, the huge U. S. Appraisers' Stores by Buchman & Kahn, and the East 45th Street loft building. Another interesting example of all-concrete exterior for industrial buildings is Albert Kahn's new service station of the Packard Company in Manhattan with its terra cotta exterior,—also S. Scott Joy's North Station Industrial Building in Boston. Some of the most interesting industrial buildings with brick exteriors have been produced by Nimmons, Carr & Wright for Sears, Roebuck & Company, including among others the Portland retail store and the mail order houses in Philadelphia, Cambridge, Memphis and Minneapolis. Nearly all the buildings here mentioned are illustrated in this issue of THE FORUM, and as the Chinese saying goes, "a picture is worth a thousand words." Frank S. Parker in New York has designed some very large concrete factory and loft buildings running as high as 22 stories, and in general has used brick for the lower stories and then gone to exposed concrete at the tops of the buildings, his theory being that the detail defects inherent in ordinary concrete exteriors are not visible at that height and that a stone-like appearance is given with real money saving. The great Printing Crafts Building is one example, and the Graphic Arts Center in New York is another.

An architect choosing all concrete for the exterior of his building would do well to consider that he is handling a plastic material different

Photo. Calvin Wheat

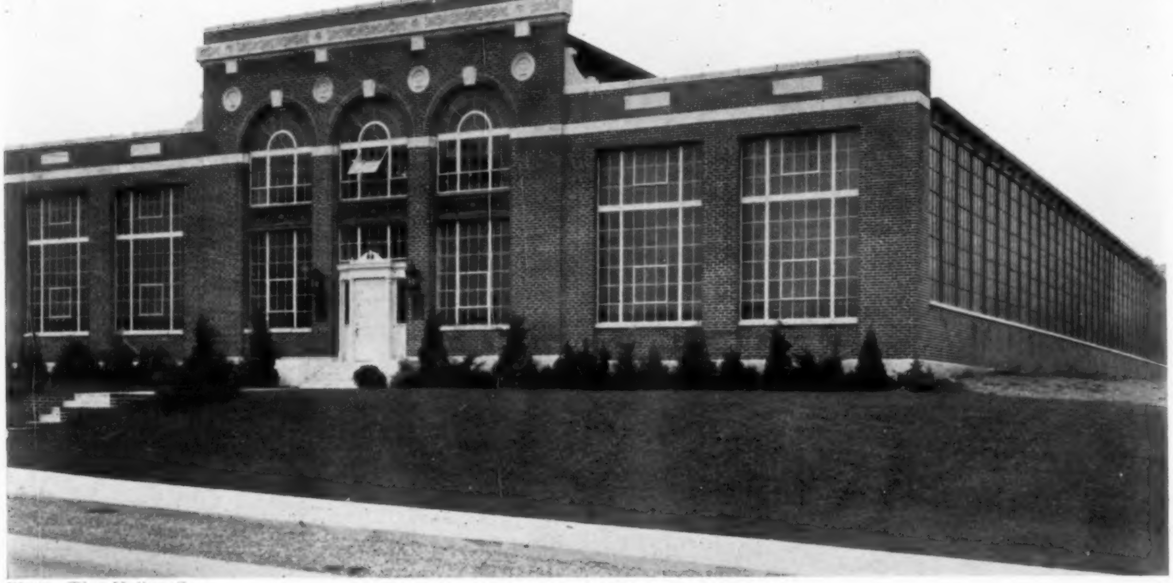
Building for Houston Press, Houston, Tex.
Howell & Thomas, Architects

Photo. Manning Bros.

Assembly Building, the Chrysler Corporation, Detroit
Smith, Hinchman & Grylls, Architects

from any other of the past. He may find that the monolithic type is best expressed through a form which is not in complete conformity with any particular classification. Concrete structures should rely for their beauty on their sense of massive strength and immovability. They should be characterized by rectangular lines, large, unbroken wall areas, deep-set windows and massive entrance ways. Frank expression of concrete's qualities of ruggedness and strength is usually the basis of the most successful design. Long vertical lines, massive columns and graceful arches lend themselves most readily to expression in this material.

Anyone reflecting on the designing of exteriors of concrete buildings over the past 25 years cannot but get a thrill, as an American, out of the great improvement which architects have brought about in the treatment of what used to be, as the figure of speech put it, "as ugly as a factory building." Today the factories of America, in the great majority of cases, are "things of beauty."



Photo, The Heller Co.

BUILDING FOR COLONIAL KNITTING MILLS, INC., PHILADELPHIA
THE AUSTIN COMPANY, ARCHITECTS

Photo, Manning Bros.

MACHINE SHOP, THE CHRYSLER CORPORATION, DETROIT
SMITH, HINCHMAN & GRYLLS, ARCHITECTS

GENERAL VIEW

Photos. Rode-Photo

MAIN ENTRANCE

BUILDING FOR PACIFIC GOODRICH RUBBER COMPANY, LOS ANGELES

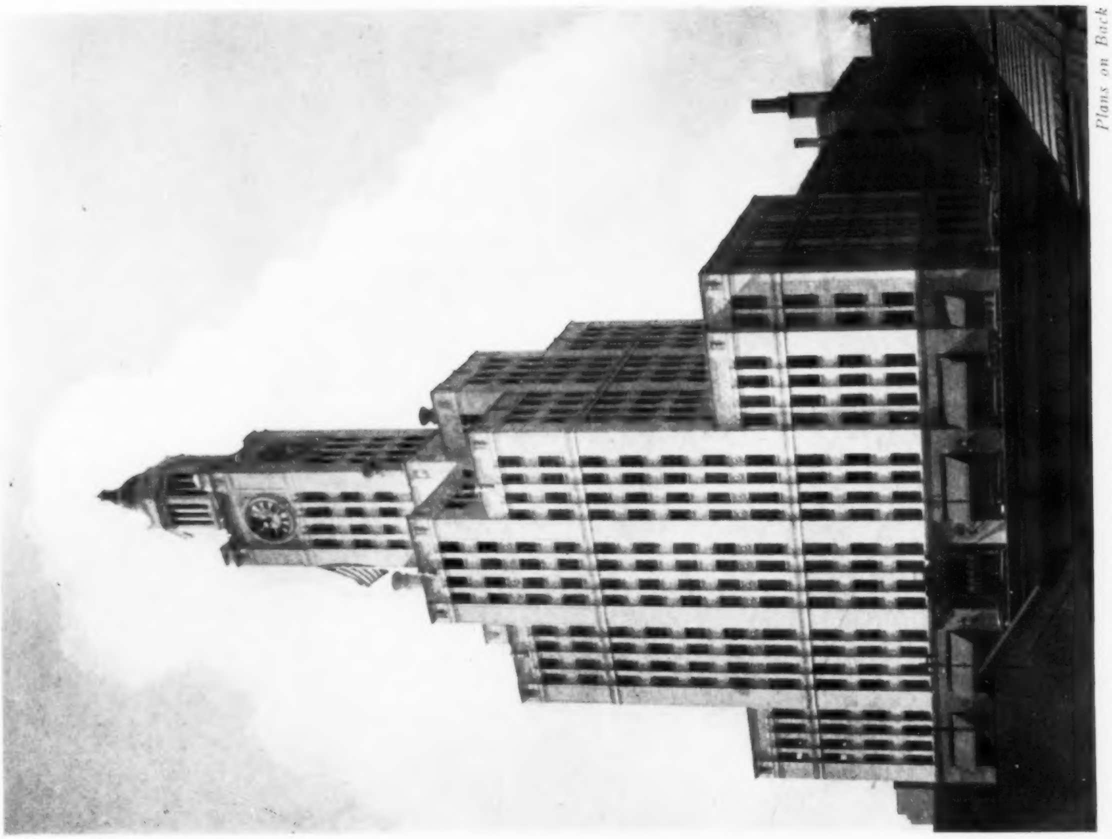
CARL JUYLES WEYL, CONSULTING ARCHITECT THE FOUNDATION COMPANY, ENGINEERS

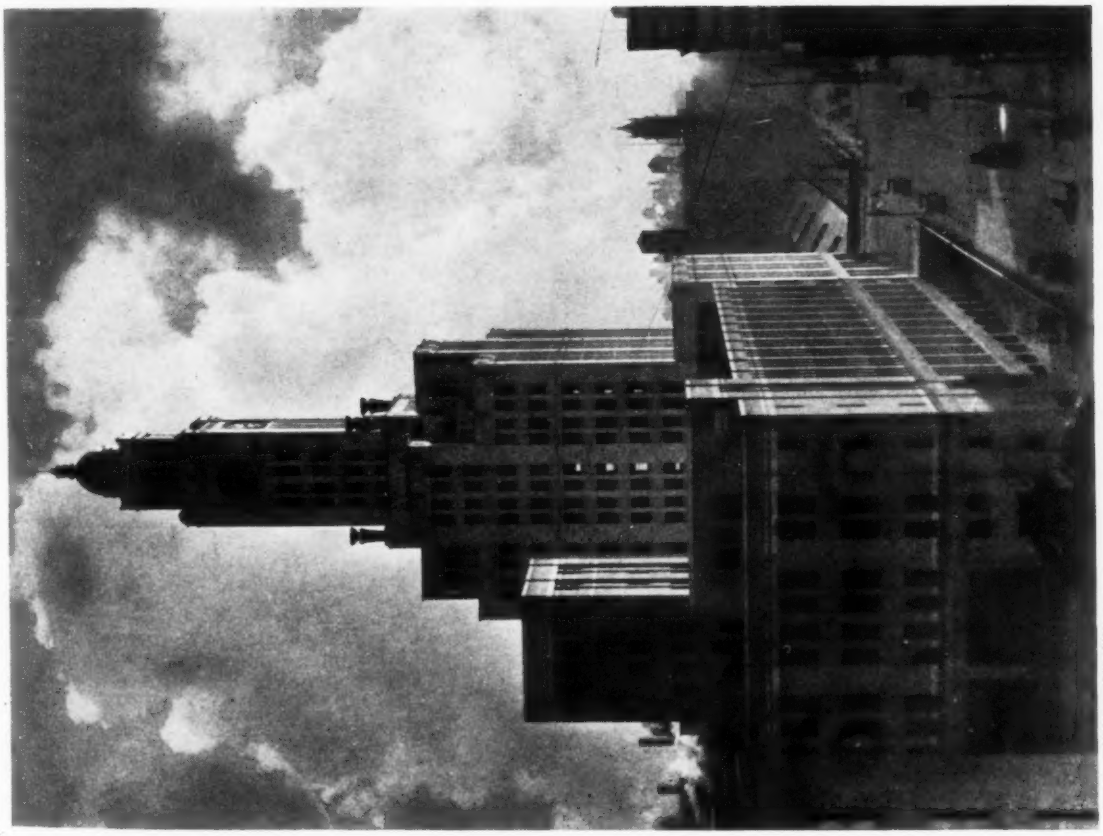
Photos. Stagg

DIRECTORS' ROOM — ENTRANCE LOBBY

BUILDING FOR PACIFIC GOODRICH RUBBER COMPANY, LOS ANGELES

CARL JUYLES WEYL, CONSULTING ARCHITECT — THE FOUNDATION COMPANY, ENGINEERS





Photos. William M. Rittase

TWO VIEWS, ELVERSON BUILDING, OCCUPIED BY THE PHILADELPHIA INQUIRER

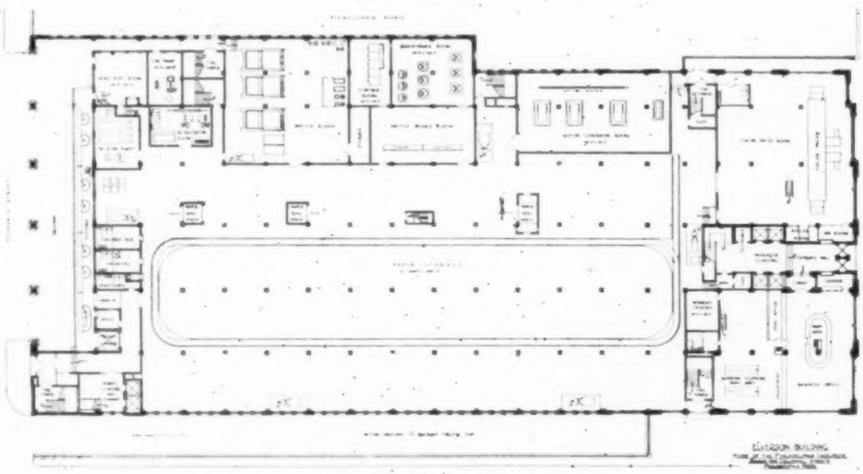
RANKIN, KELLOGG & CRANE, ARCHITECTS

Plans on Back

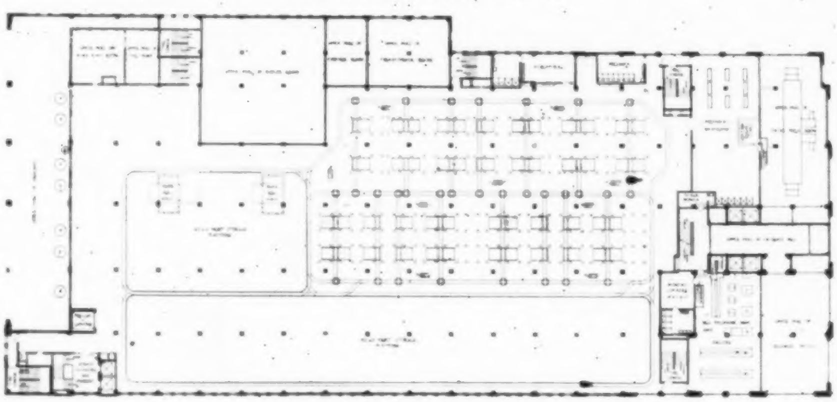
COST AND CONSTRUCTION DATA

Year of Completion: 1925.
Type of Construction: Steel frame.
Exterior Materials: Brick and terra cotta.
Floors: Concrete slabs.
Lighting: Electricity.
Heating: Steam; oil burners.
Ventilating: Forced for special areas.
Cubic Foot Cost: 46 cents.
Total Cost: $3,412,000.
Use of Building: Newspaper publishing plant.

FOURTH FLOOR



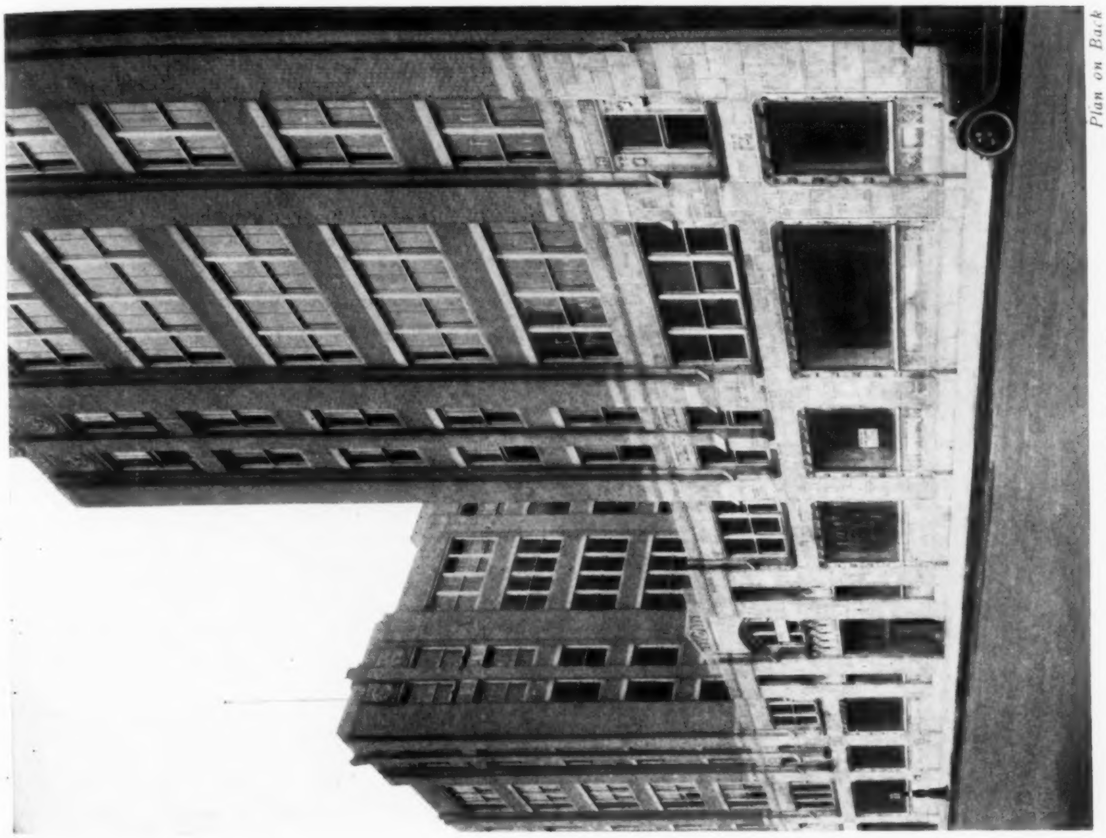
PAPER STORAGE FLOOR

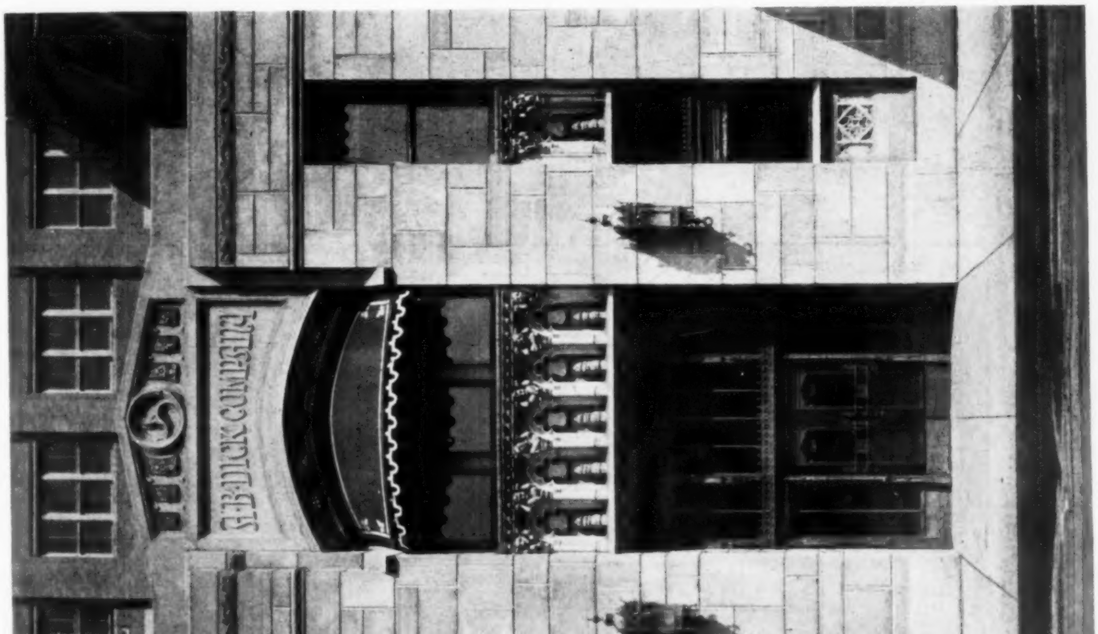


REEL ROOM FLOOR

PLANS, ELVERSON BUILDING, PHILADELPHIA, OCCUPIED BY THE PHILADELPHIA INQUIRER

RANKIN, KELLOGG & CRANE, ARCHITECTS





MAIN ENTRANCE

STREET FACADE

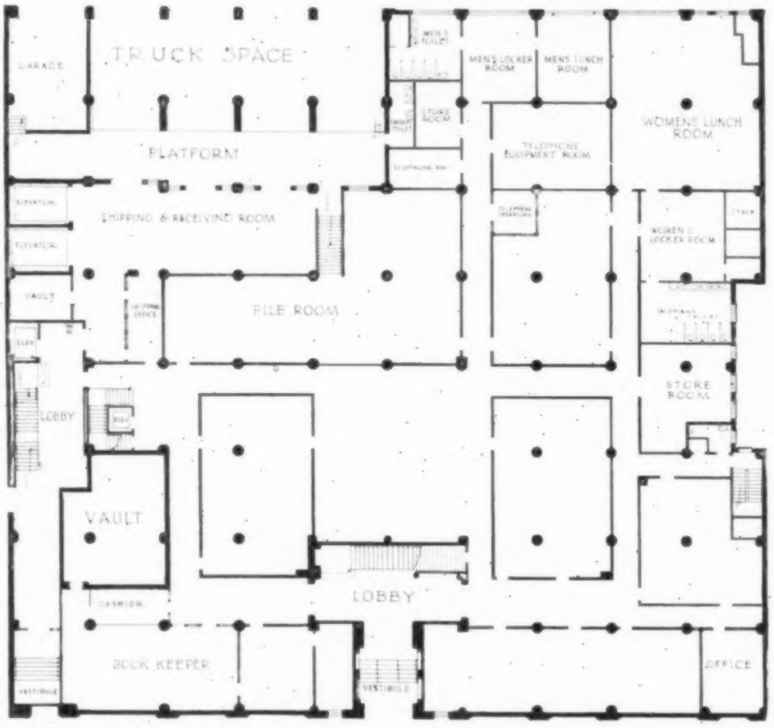
BUILDING FOR A. B. DICK COMPANY, CHICAGO

ALFRED S. ALSCHULER, ARCHITECT

Plan on Back

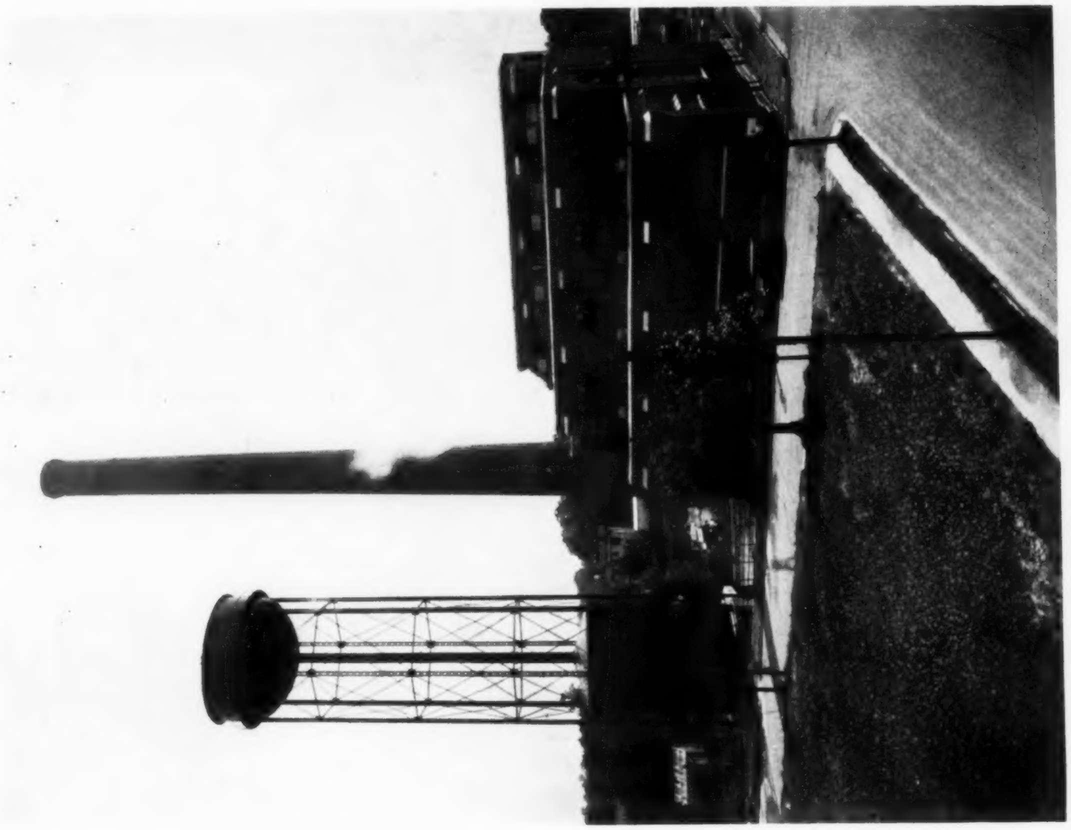
CONSTRUCTION DATA

Year of Completion: 1926.
Exterior Materials: Limestone and face brick.
Interior Materials: Walnut trim; marble in vestibule.
Floors: Maple, laid over a flat slab of reinforced concrete; offices, rubber tile; entrance lobby, marble.
Windows: Front elevation, wood sash; rear elevation, steel sash.
Lighting: Indirect in offices; typical factory units in work spaces.
Heating: Vacuum type with wall radiation.
Ventilating: Air conditioning apparatus and thermostatic control.
Use of Building: Assembling, storage and shipment of machines, and show rooms and general offices.



FIRST FLOOR

PLAN, BUILDING FOR A. B. DICK COMPANY, CHICAGO
ALFRED S. ALSCHULER, ARCHITECT



POWER PLANT, LIGGETT & MYERS TOBACCO CO., DURHAM, N. C.

DESIGNED BY LOCKWOOD GREENE ENGINEERS, INC.

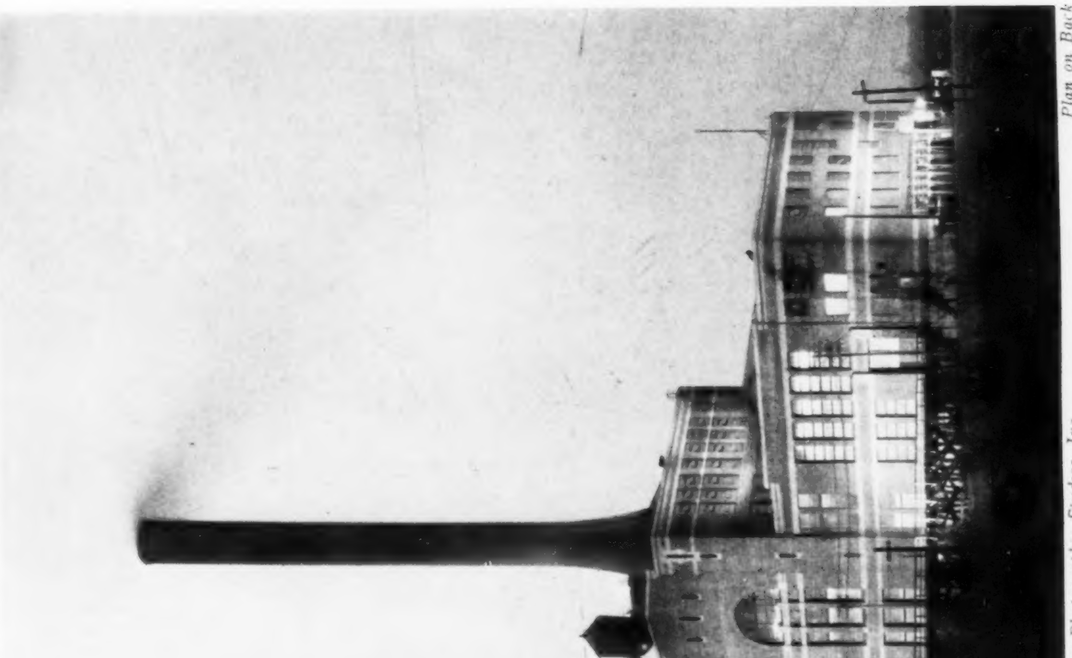


Photo. Northwestern Photographic Studios, Inc.

Plan on Back

ISLAND STATION POWER PLANT, NORTHERN STATES POWER CO., ST. PAUL

TOLTZ, KING & DAY, ARCHITECTS

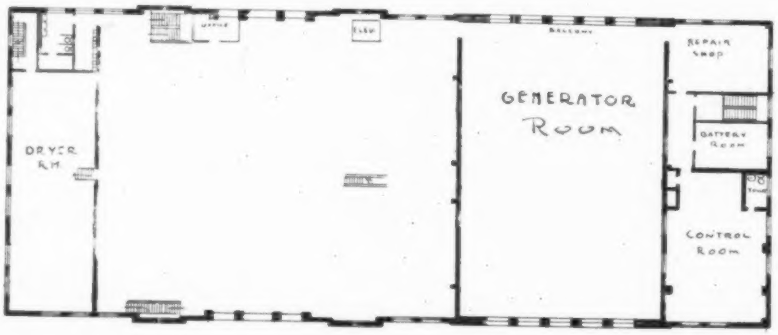
CONSTRUCTION DATA

Type of Construction: Brick and steel.
Exterior Materials: Brick.
Interior Materials: Concrete floor and roof.
Floors: Concrete.
Windows: Steel.
Lighting: Electricity.
Heating: Boiler house.
Use of Building: Power plant.

(ABOVE) POWER PLANT, LIGGETT & MYERS TOBACCO CO., DURHAM, N. C.
DESIGNED BY LOCKWOOD GREENE, ENGINEERS, INC.

COST AND CONSTRUCTION DATA

Year of Completion: 1924.
Type of Construction: Reinforced concrete up to boiler room floor level; structural steel frame above.
Exterior Materials: Face brick trimmed with cast concrete.
Interior Materials: Walls enameled brick.
Floors: Quarry tile in turbine room; cement floors in boiler plant.
Windows: Steel sash.
Heating: Steam.
Cubic Foot Cost: Approximately 25 cents.
Total Cost: $600,000.



PLAN, ISLAND STATION POWER PLANT, NORTHERN STATES POWER CO., ST. PAUL
TOLTZ, KING & DAY, ARCHITECTS

NORTH STATION INDUSTRIAL BUILDING, BOSTON
S. SCOTT JOY, ARCHITECT

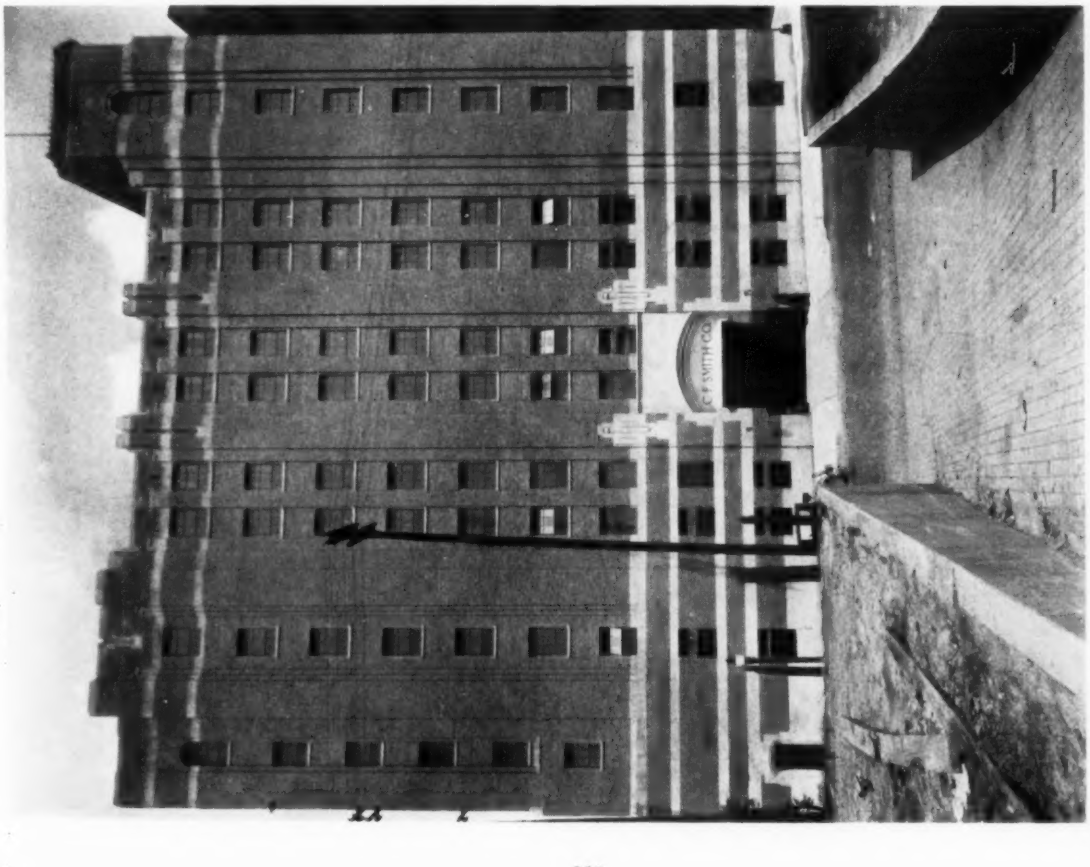


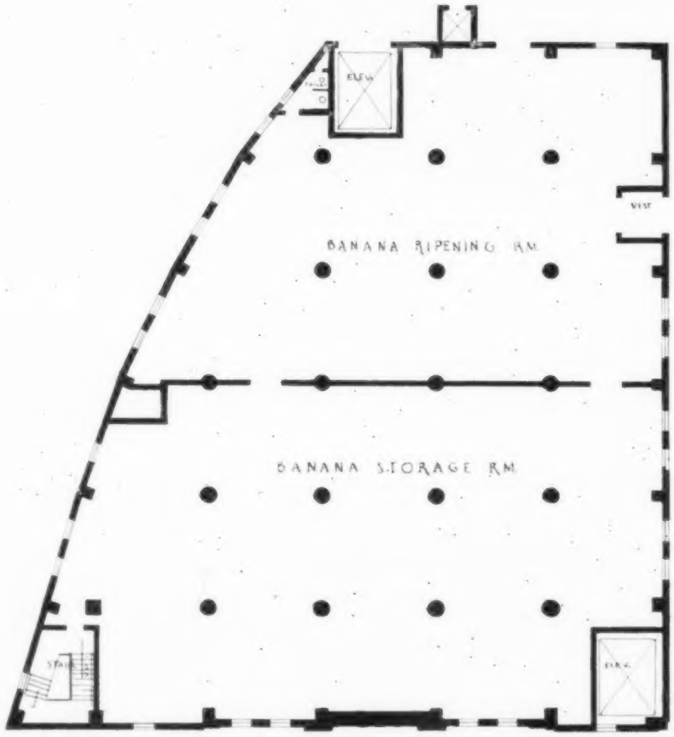
Photo. Thomas Ellison

C. F. SMITH CO. WAREHOUSE, DETROIT
SMITH, HINCHMAN & GRYLLS, ARCHITECTS

Plan on Back

CONSTRUCTION DATA

Type of Construction: Reinforced concrete.
Exterior Materials: Brick with stone trim.
Interior Materials: Brick and concrete.
Floors: Cement.
Windows: Standard steel side wall sash, with reversible type sash on north wall.
Lighting: Direct.
Use of Building: Warehouse for grocery chain stores.



FIRST FLOOR

PLAN. C. F. SMITH COMPANY WAREHOUSE, DETROIT
SMITH, HINCHMAN & GRYLLS, ARCHITECTS

Plan on Back

BUILDING FOR PHILADELPHIA WHOLESALE DRUG CO.
RANKIN & KELLOGG, ARCHITECTS

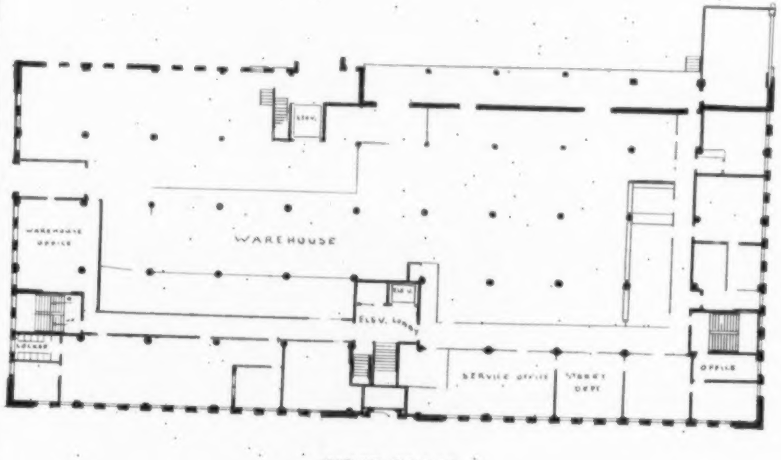
Photo. Northwestern Photographic Studios, Inc.

Plan on Back

SERVICE BUILDING, NORTHERN STATES POWER CO., ST. PAUL
TOLTZ, KING & DAY, ARCHITECTS

COST AND CONSTRUCTION DATA

Year of Completion: 1925.
Type of Construction: Reinforced concrete; frame building.
Exterior Materials: Brick and stone.
Floors: Cement.
Windows: Double-hung steel.
Lighting: Semi and direct throughout office areas; direct factory lighting throughout warehouse areas.
Heating: Steam, vacuum system, including boiler plant
Cubic Foot Cost: 28 cents.
Total Cost: Approximately $320,000.
Use of Building: Service and repair departments for power company and for warehouse for construction materials for city.



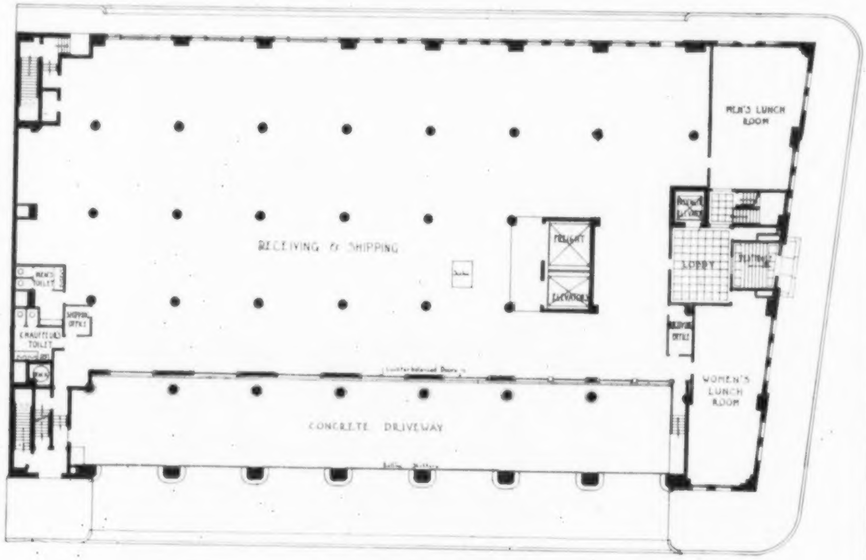
FIRST FLOOR

PLAN. SERVICE BUILDING, NORTHERN STATES POWER CO., ST. PAUL

TOLTZ, KING & DAY, ARCHITECTS

COST AND CONSTRUCTION DATA

Year of Completion: 1928.
Type of Construction: Reinforced concrete; mushroom columns.
Exterior Walls: Brick and stone.
Roof: Built-up.
Floors: Concrete.
Heating: Low-pressure steam.
Cubage of Buildings: 2,450,000.
Cubic Foot Costs: 24 cents.
Total Cost of Building: $588,000.



FIRST FLOOR

PLAN. BUILDING FOR PHILADELPHIA WHOLESALE DRUG COMPANY

RANKIN & KELLOGG, ARCHITECTS

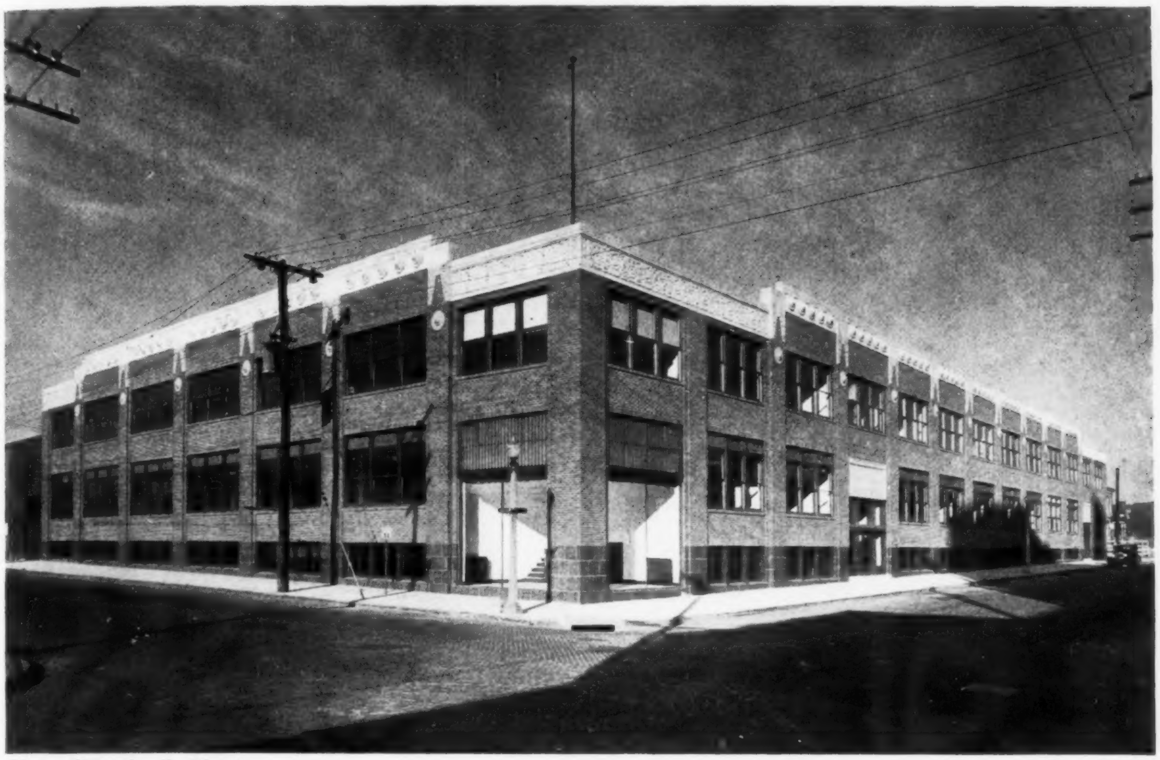


Photo. Alexander E. Piaget

Plan on Back

BUILDING FOR N. O. NELSON CO., ST. LOUIS
PRESTON J. BRADSHAW, ARCHITECT

Photo. Graham Photo Co.

BUILDING FOR COMMUNITY LAUNDRY, LOS ANGELES
W. J. SAUNDERS, ARCHITECT

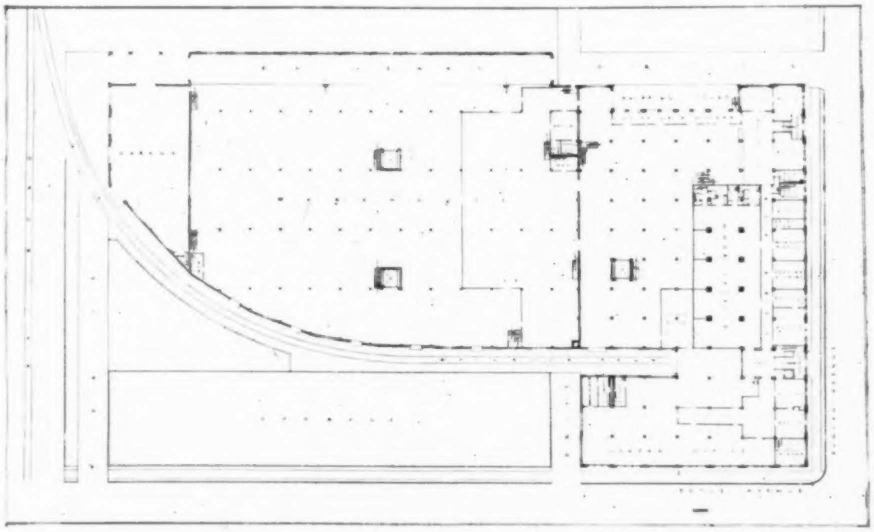
COST AND CONSTRUCTION DATA

Year of Completion: 1929.
Type of Construction: Reinforced concrete.
Exterior Materials: Plaster.
Interior Materials: Plaster.
Floors: Concrete.
Windows: Steel sash.
Lighting: Electricity.
Heating: Steam.
Total Cost: $180,000.

BUILDING FOR COMMUNITY LAUNDRY, LOS ANGELES
W. J. SAUNDERS, ARCHITECT

COST AND CONSTRUCTION DATA

Year of Completion: 1929.
Type of Construction: Fireproof.
Exterior Materials: Brick and terra cotta.
Interior Materials: Plaster, marble and zenitherm.
Floors: Cement and hardwood.
Windows: Wood and steel.
Lighting: Regular and ornamental.
Heating: Steam.
Ventilating: Mechanical.
Cubic Foot Cost: Approximately 21 cents.
Total Cost: Approximately $299,000.
Use of Building: Plumbing supply display, warehouse and general offices.



FIRST FLOOR

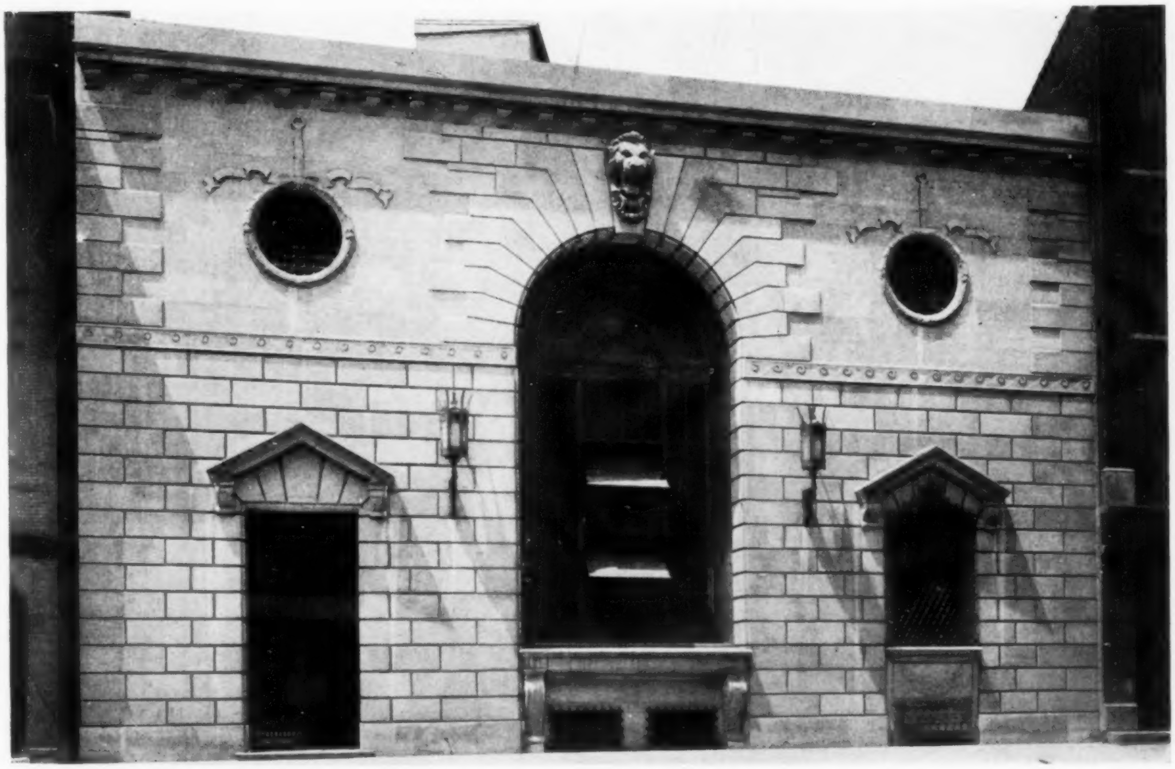
PLAN. BUILDING FOR N. O. NELSON CO., ST. LOUIS
PRESTON J. BRADSHAW, ARCHITECT

Photo. Alexander E. Piaget

Plan on Back

PLAZA SUB-STATION, UNION ELECTRIC LIGHT & POWER CO., ST. LOUIS

LA BEAUME & KLEIN, ARCHITECTS

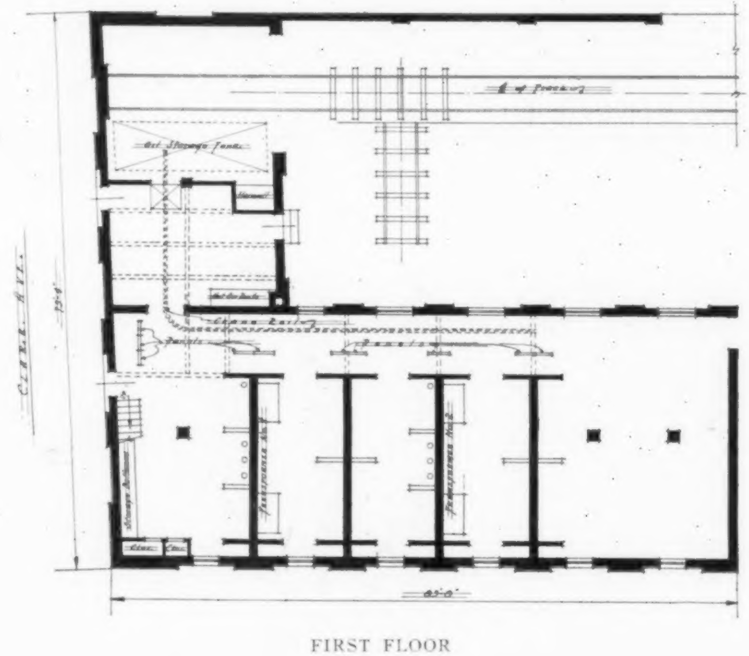


BUILDING FOR EDISON COMPANY, CHICAGO

HOLABIRD & ROOT, ARCHITECTS

COST AND CONSTRUCTION DATA

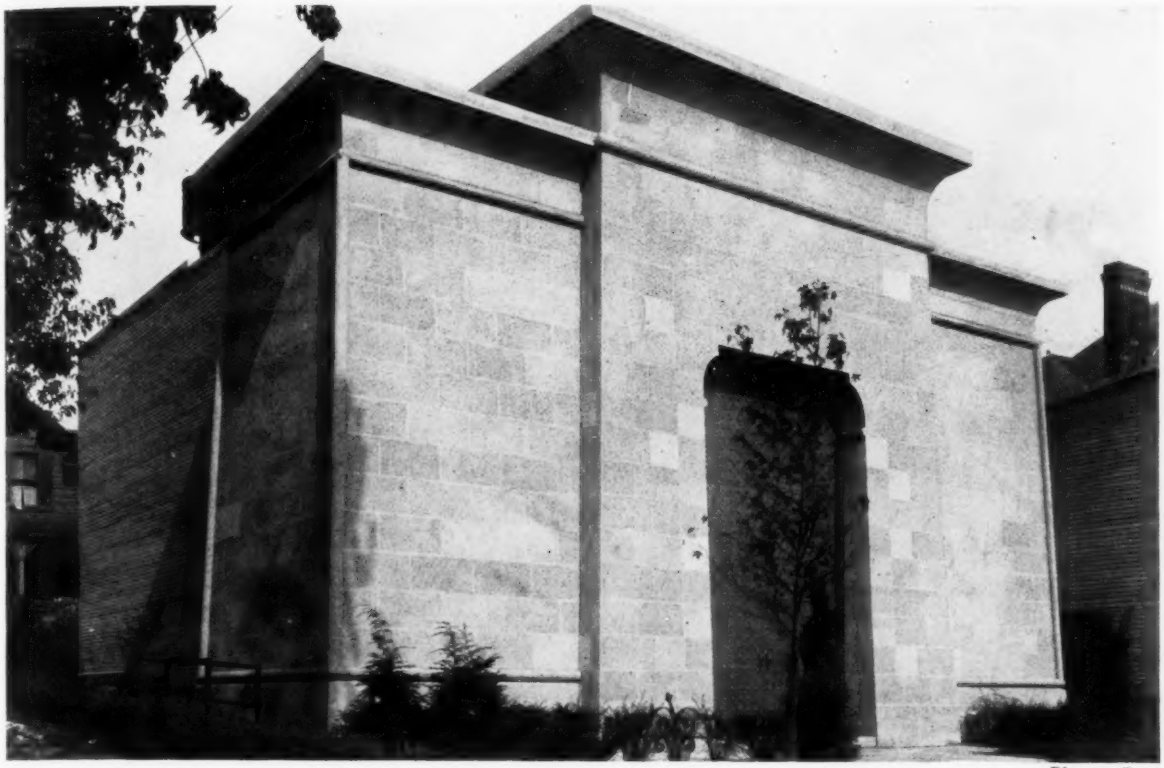
Year of Completion: 1928.
Type of Construction: Fireproof brick; reinforced concrete.
Exterior Materials: Stone.
Interior Materials: Brick.
Floors: Concrete.
Windows: Steel.
Ventilating: Louvers.
Cubic Foot Cost: 52 cents.
Total Cost: $75,000, exclusive of equipment.
Use of Building: Transformer sub-station.



FIRST FLOOR

PLAN. PLAZA SUB-STATION, UNION ELECTRIC LIGHT & POWER CO., ST. LOUIS

LA BEAUME & KLEIN, ARCHITECTS



Plan on Back

DELTA AVENUE STATION, CINCINNATI STREET RAILWAY, CINCINNATI
HAKE & KUCK, ARCHITECTS

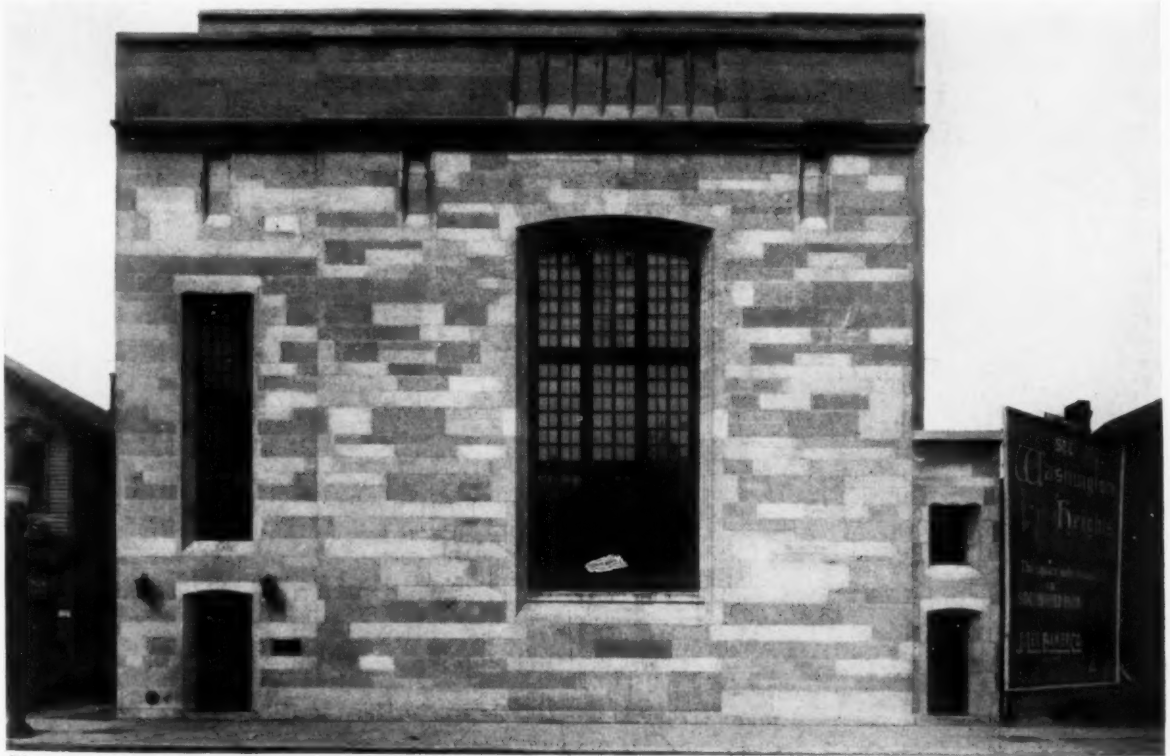


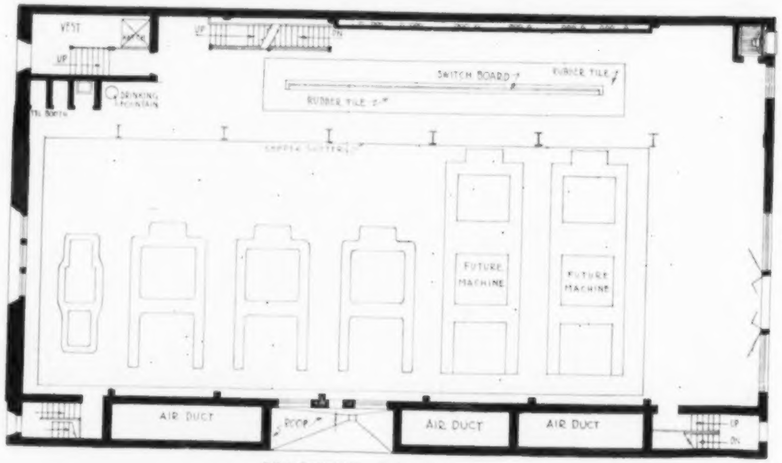
Photo. Manning Bros.

Plan on Back

CHARLOTTE AVENUE SUB-STATION, DETROIT EDISON COMPANY
DESIGNED BY DRAFTING & SURVEYING BUREAU, DETROIT EDISON COMPANY

COST AND CONSTRUCTION DATA

Year of Completion: 1926.
Type of Construction: Fireproof.
Exterior Materials: Face brick and limestone front.
Interior Materials: Pressed brick.
Floors: Main floors, quarry tile on reinforced concrete.
Windows: Steel sash.
Lighting: Direct.
Heating: Steam.
Ventilating: Mechanical.
Cubic Foot Cost: Approximately 50 cents for superstructure.
Total Cost: Approximately $280,000.
Use of Building: Electric sub-station.



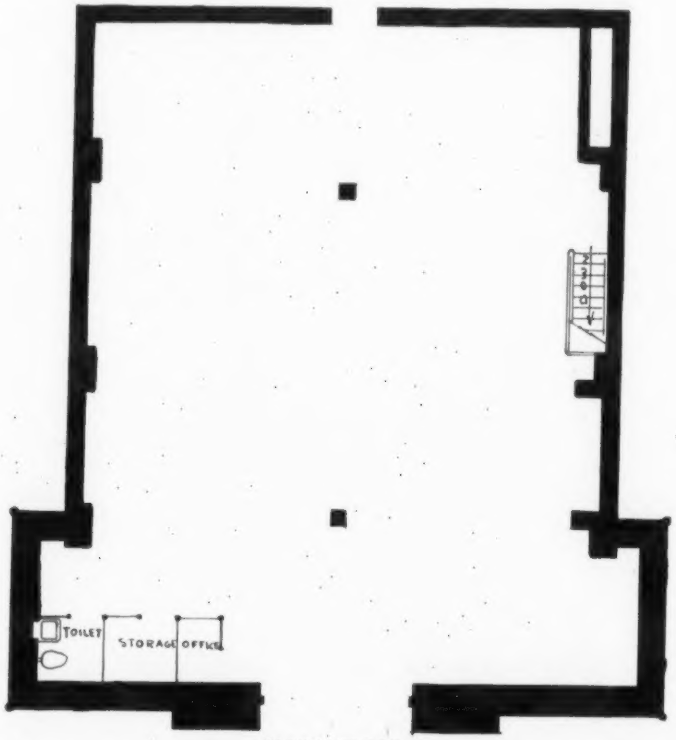
MACHINE ROOM PLAN

PLAN: CHARLOTTE AVENUE SUB-STATION, DETROIT EDISON COMPANY

DESIGNED BY DRAFTING & SURVEYING BUREAU, DETROIT EDISON CO.

COST AND CONSTRUCTION DATA

Year of Completion: 1928.
Type of Construction: Reinforced concrete and structural steel.
Exterior Materials: Limestone.
Interior Materials: Face brick wall; exposed concrete ceilings.
Floors: Cement.
Lighting: Electric.
Ventilating: Gravity ventilators.
Cubic Foot Cost: 61 cents.
Total Cost: $35,266.
Use of Building: Transformer sub-station.



FIRST FLOOR

PLAN. DELTA AVENUE STATION, CINCINNATI STREET RAILWAY, CINCINNATI

HAKE & KUCK, ARCHITECTS

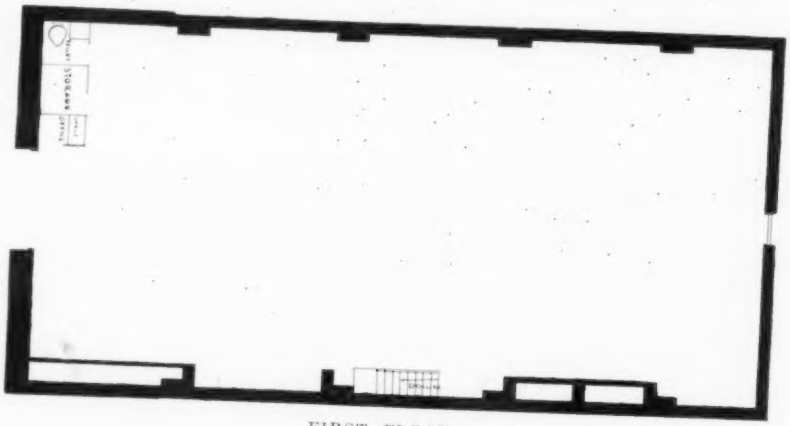
Plan on Back

LINCOLN STATION, CINCINNATI STREET RAILWAY
HAKE & KUCK, ARCHITECTS

O'BRIEN STREET STATION, CINCINNATI STREET RAILWAY
HAKE & KUCK, ARCHITECTS

COST AND CONSTRUCTION DATA

Year of Completion: 1928.
Type of Construction: Reinforced concrete and structural steel.
Exterior Materials: Limestone.
Interior Materials: Face brick wall: exposed concrete ceilings.
Floors: Cement.
Lighting: Electricity.
Ventilating: Gravity ventilators.
Cubic Foot Cost: 53 cents.
Total Cost: $48,000.
Use of Building: Transformer sub-station.



FIRST FLOOR

PLAN, LINCOLN STATION, CINCINNATI STREET RAILWAY CO.
HAKE & KUCK, ARCHITECTS

Photo. Mott Studios *Plan on Back*

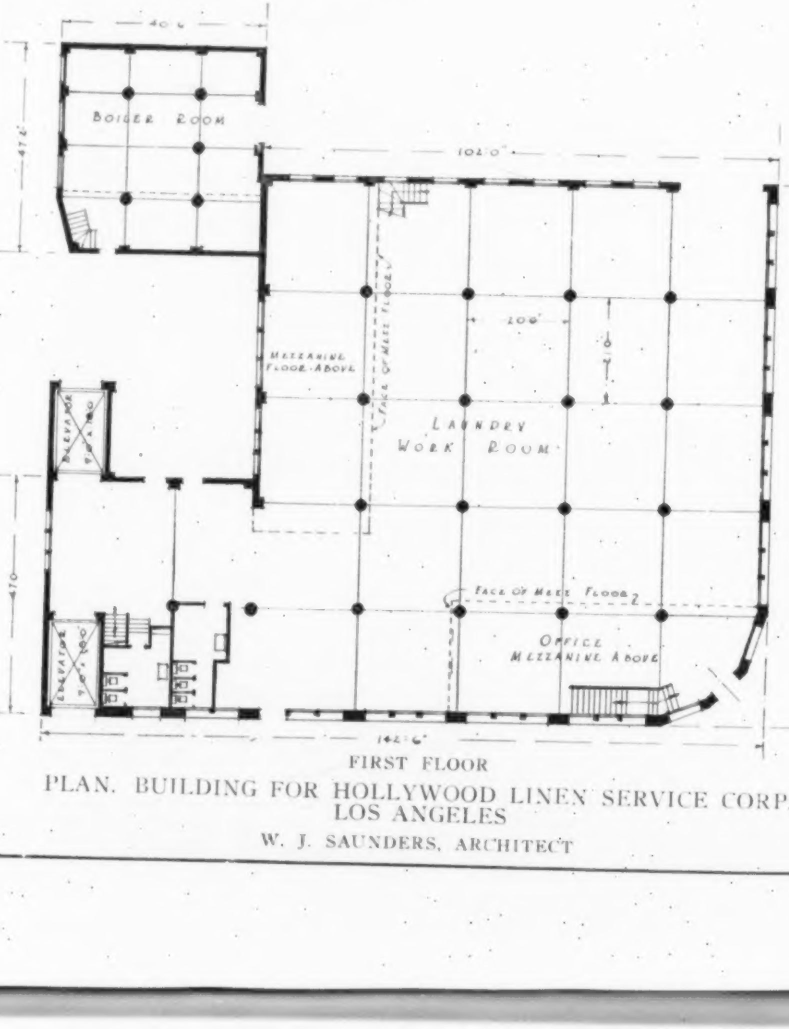
BUILDING FOR ADOHR CREAMERY CO., LOS ANGELES
MORGAN, WALLS & CLEMENTS, ARCHITECTS

Photo. Graham Photo Co. *Plan on Back*

BUILDING FOR HOLLYWOOD LINEN SERVICE CORP., LOS ANGELES
W. J. SAUNDERS, ARCHITECT

COST AND CONSTRUCTION DATA

Year of Completion: 1929.
Type of Construction: Reinforced concrete.
Exterior Materials: Cement.
Interior Materials: Cement and plaster.
Floors: Flat slab.
Windows: Steel sash.
Lighting: Electric.
Heating: Gas radiators for office spaces.
Total Cost: $100,000.



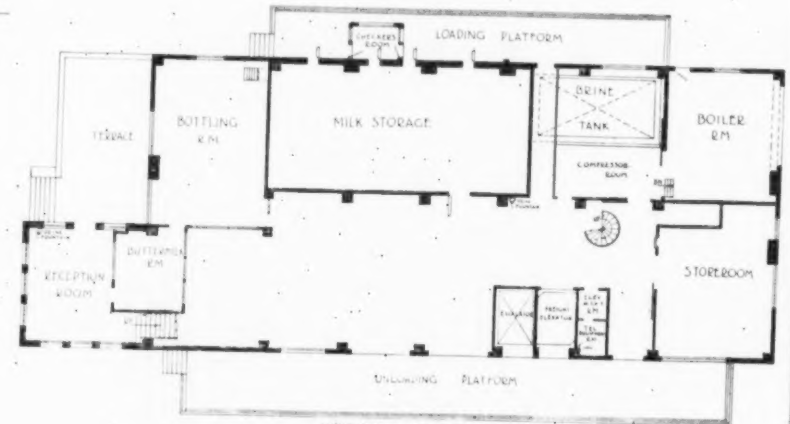
FIRST FLOOR

PLAN. BUILDING FOR HOLLYWOOD LINEN SERVICE CORP., LOS ANGELES

W. J. SAUNDERS, ARCHITECT

COST AND CONSTRUCTION DATA

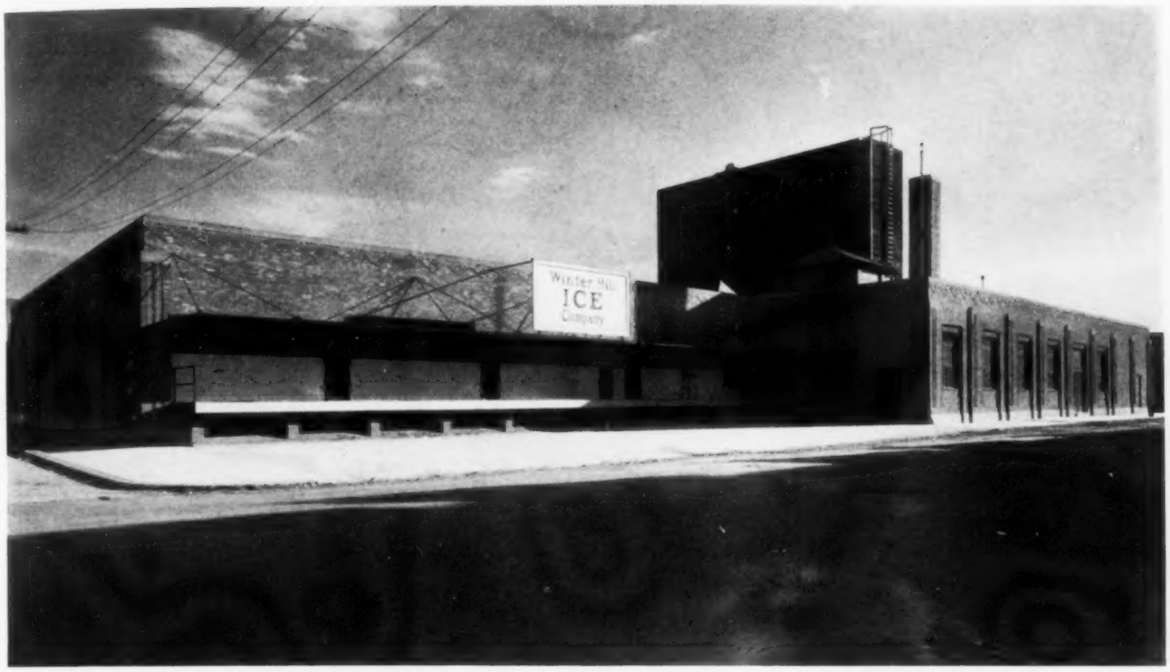
Year of Completion: 1926.
Type of Construction: Reinforced concrete.
Exterior Materials: Plaster, cast stone trim.
Interior Materials: Plaster.
Floors: Cement.
Windows: Steel sash.
Lighting: General illumination.
Heating: Steam.
Total Cost: $115,000.
Use of Building: Milk plant.



FIRST FLOOR

PLAN. BUILDING FOR ADOHR CREAMERY CO., LOS ANGELES

MORGAN, WALLS & CLEMENTS, ARCHITECTS



GENERAL VIEW

Photos. Paul J. Weber

Plan on Back

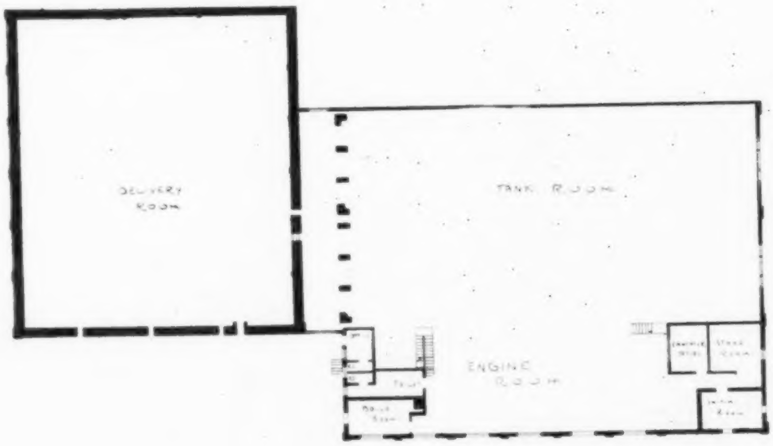
FRONT ELEVATION

BUILDING FOR BOSTON ICE CO., CAMBRIDGE, MASS.

C. LESLIE WEIR, ARCHITECT

COST AND CONSTRUCTION DATA

Year of Completion: 1928.
Type of Construction: Brick; steel frame; wood roof.
Exterior Materials: Brick.
Interior Materials: Face brick.
Floors: Tile.
Windows: Galvanized iron sash.
Lighting: Electricity.
Heating: Steam.
Cubic Foot Cost: 21 cents.
Total Cost: \$70,000.
Use of Building: Ice manufacturing plant.



FIRST FLOOR

PLAN. BUILDING FOR BOSTON ICE CO., CAMBRIDGE, MASS.

Photo. Keystone Photo Service

BUILDING FOR THE KITTINGER COMPANY, LOS ANGELES

DESIGNED BY THE KITTINGER COMPANY

Photos. Paul J. Weber

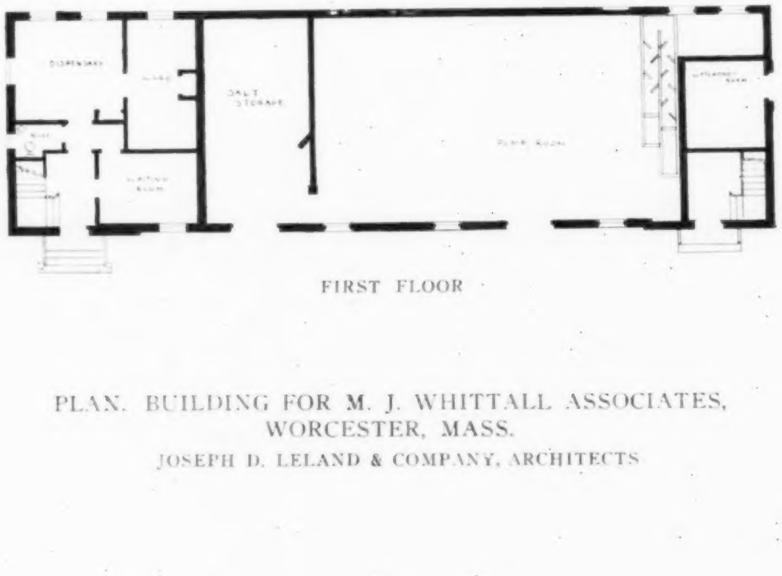
Plan on Back

BUILDING FOR M. J. WHITTALL ASSOCIATES, WORCESTER, MASS.

JOSEPH D. LELAND & COMPANY, ARCHITECTS

COST AND CONSTRUCTION DATA

Year of Completion: 1927.
Type of Construction: First class, with wood roof.
Exterior Materials: Brick and artificial stone.
Interior Materials: Walls and ceilings of plaster except in water softening room which is unfinished.
Floors: First floor, concrete; second floor, maple; magnesite in dispensary.
Windows: Copper covered.
Lighting: Electricity.
Heating: Steam.
Cubic Foot Cost: 49 cents.
Total Cost: $61,000.
Use of Building: On the first floor a water softening plant and dispensary; second floor, designing room for a rug mill.



FIRST FLOOR

PLAN. BUILDING FOR M. J. WHITTALL ASSOCIATES, WORCESTER, MASS.
JOSEPH D. LELAND & COMPANY, ARCHITECTS

ENTRANCE, BUILDING FOR M. J. WHITTALL ASSOCIATES, WORCESTER, MASS.

JOSEPH D. LELAND & COMPANY, ARCHITECTS

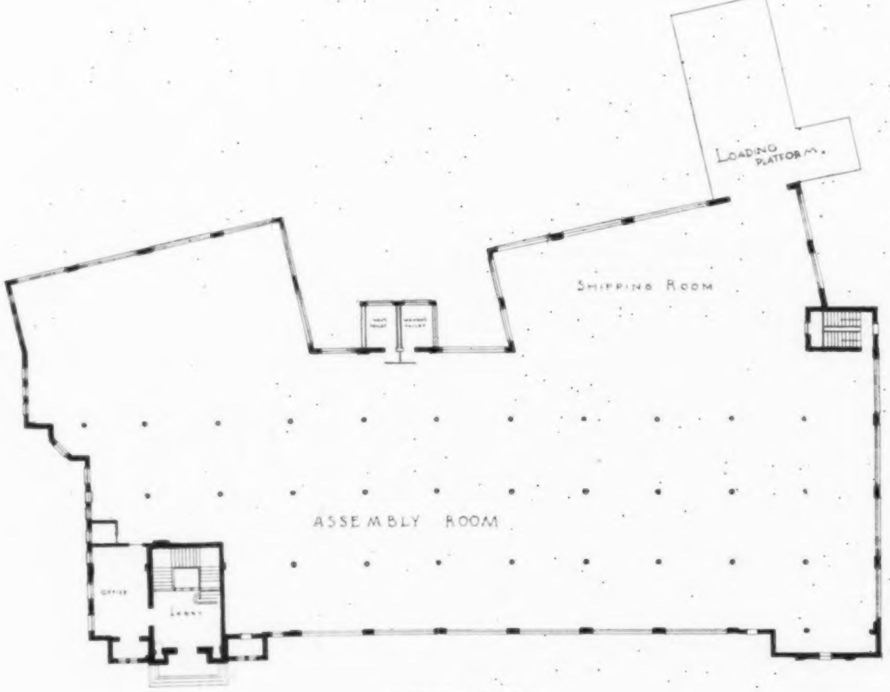
ENTRANCE, BUILDING FOR THE KITTINGER COMPANY, LOS ANGELES

DESIGNED BY THE KITTINGER COMPANY

Plan on Back

COST AND CONSTRUCTION DATA

Year of Completion: 1929.
Type of Construction: Reinforced concrete; flat slab.
Exterior Materials: Concrete.
Interior Materials: Concrete.
Floors: Concrete.
Windows: Steel sash.
Lighting: Direct by drop cords.
Heating: Unit gas heaters.
Cubic Foot Cost: 21 cents.
Total Cost: $100,000.
Use of Building: Manufacturing, storage and show rooms for furniture.



FIRST FLOOR

PLAN. BUILDING FOR THE KITTINGER COMPANY, LOS ANGELES
DESIGNED BY THE KITTINGER COMPANY

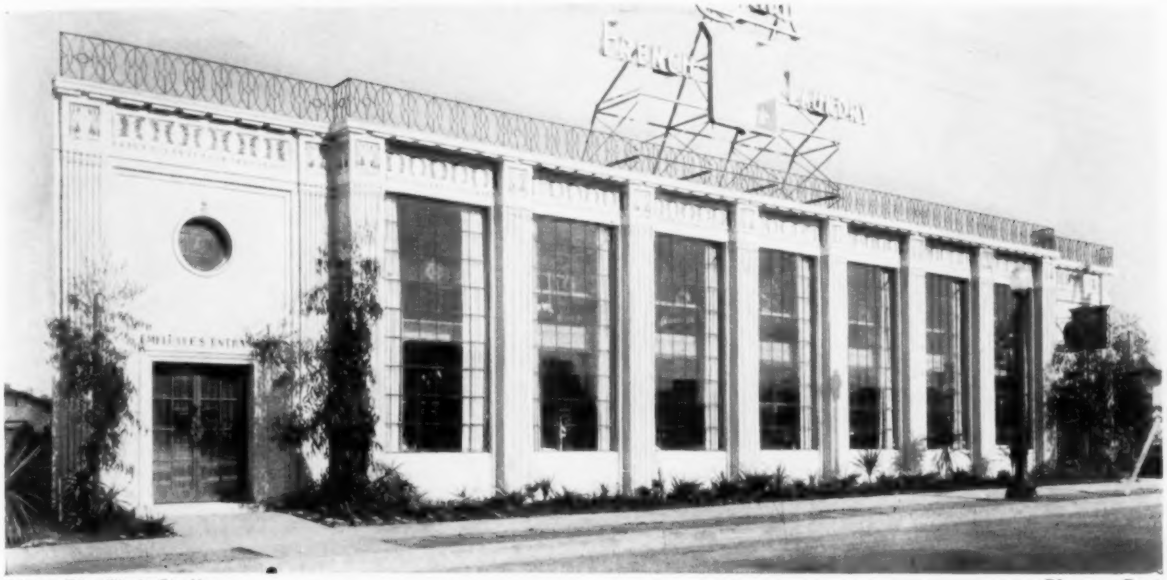
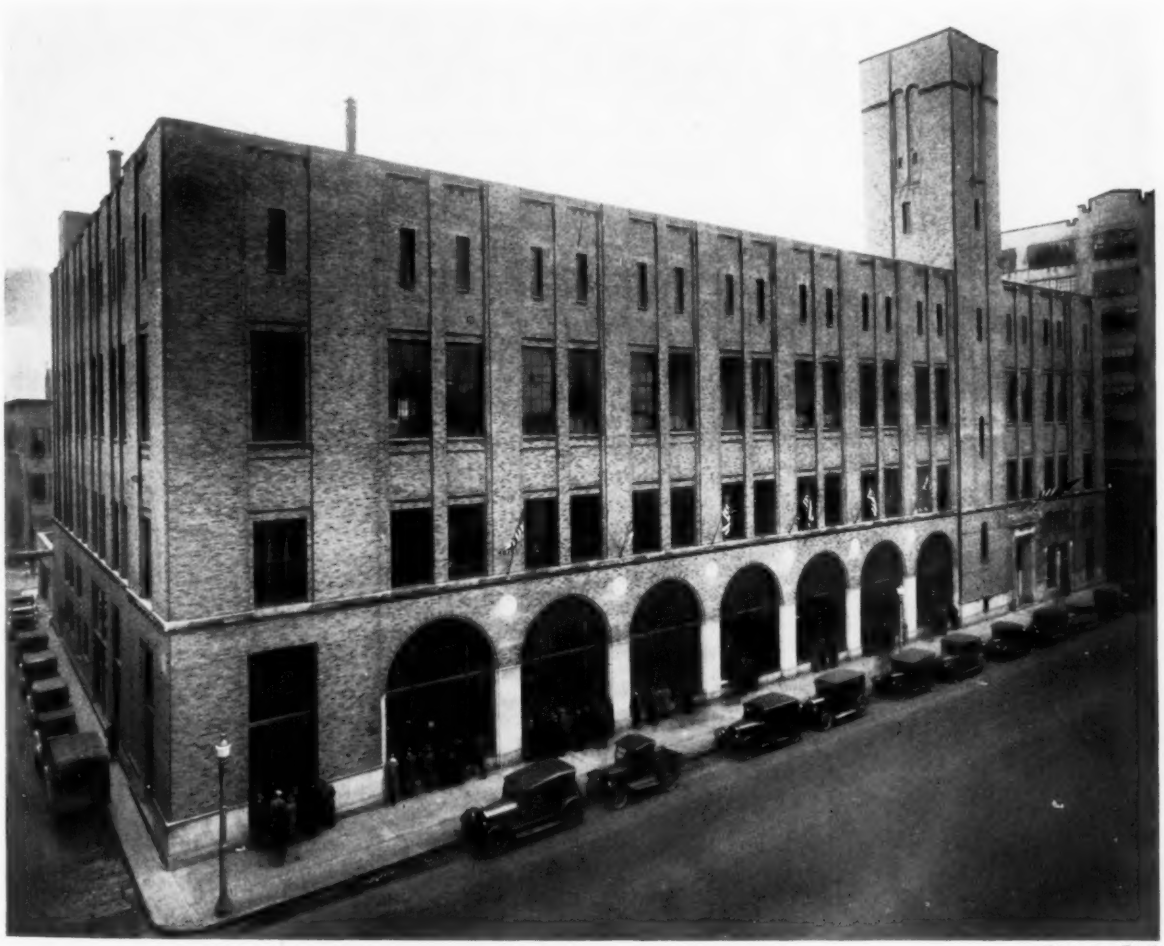


Photo. The Fitch Studio

Plan on Back

BUILDING FOR ORIGINAL FRENCH LAUNDRY, SAN DIEGO
FRANK P. ALLEN, ARCHITECT

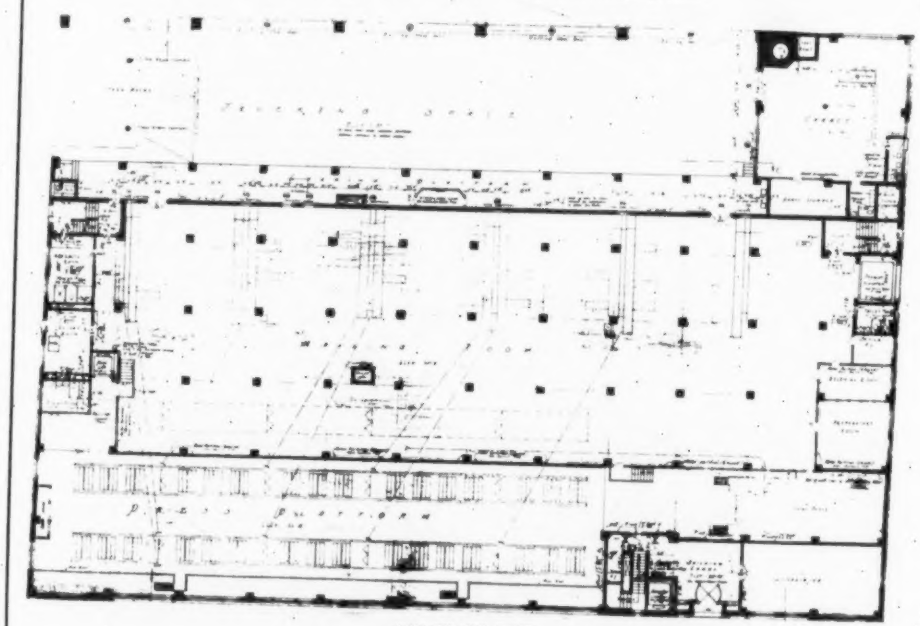


Plan on Back

BUILDING FOR THE PITTSBURGH PRESS
HOWELL & THOMAS, ARCHITECTS

COST AND CONSTRUCTION DATA

Year of Completion: 1927.
Type of Construction: Steel frame; hollow tile floor arches; fireproof throughout.
Exterior Materials: Brick.
Floors: Mechanical rooms, wood block; offices, rubber tile.
Windows: Metal.
Lighting: Semi-direct.
Heating: Steam.
Ventilating: Forced air and discharge.
Cubic Foot Cost: 70 cents.
Total Cost: $1,750,000.
Use of Building: Newspaper publishing plant.

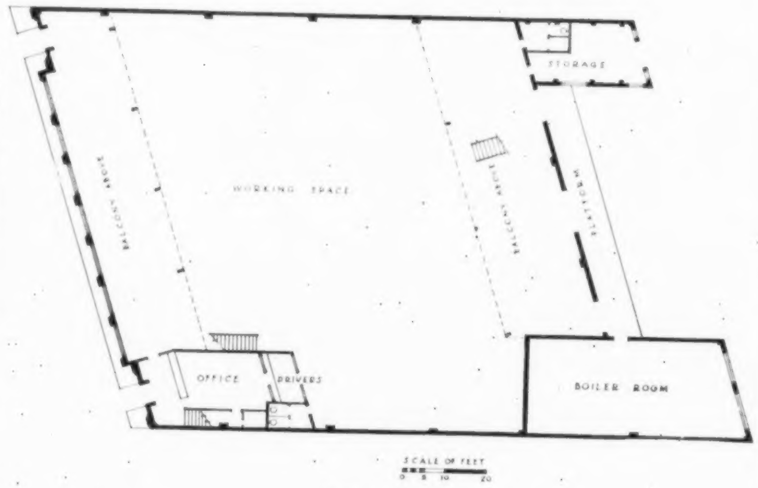


FIRST FLOOR

PLAN. BUILDING FOR THE PITTSBURGH PRESS
HOWELL & THOMAS, ARCHITECTS

CONSTRUCTION DATA

Type of Construction: Concrete.
Exterior Materials: Cement and tile.
Floors: Concrete and wood.
Windows: Steel sash.
Use of Building: Laundry.



FIRST FLOOR

PLAN. BUILDING FOR ORIGINAL FRENCH LAUNDRY, SAN DIEGO
FRANK P. ALLEN, ARCHITECT

THE DESIGNING OF POWER STATIONS

BY

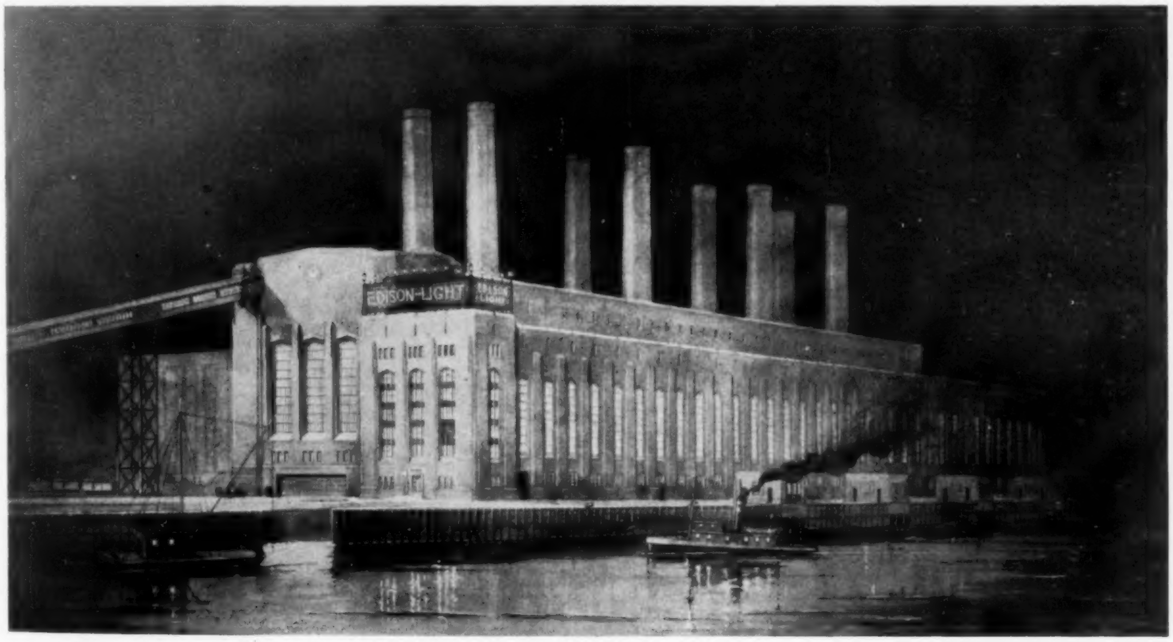
DONALD DES GRANGES

AFTER all the great wars in history, the victors have grown to recognize their power, their abilities, and their capacities for conquering in fields other than that of war. Since the Great War, we in this country have been progressing as was never even dreamed of prior to that catastrophic event, as is evidenced in our great commercial development, our recent vast business consolidations and unification of public utilities to better serve the public. These latter have brought into being central power plants on a scale and magnitude never before conceived. These great structures from 100 to 150 feet high and a thousand feet long are designed to generate electricity up to hundreds of thousands of kilowatts.

These buildings naturally have a tremendous influence upon the communities in which they are located; they, like great railroad terminals, are being looked upon as institutions of public service. Therefore, a certain architectural dignity to give the impressiveness demanded of semi-public buildings is being required. And a civic consciousness is being developed among some of the public utilities, so that they not only take pride in their buildings, but in the layout of their grounds and outlying buildings and develop park-like surroundings which add very materially to the good impression which the public has of these large corporations. If the buildings are located in remote locations, as hydroelectric stations frequently are, the beauty of the surroundings alone calls for beauty and dignity in the buildings.

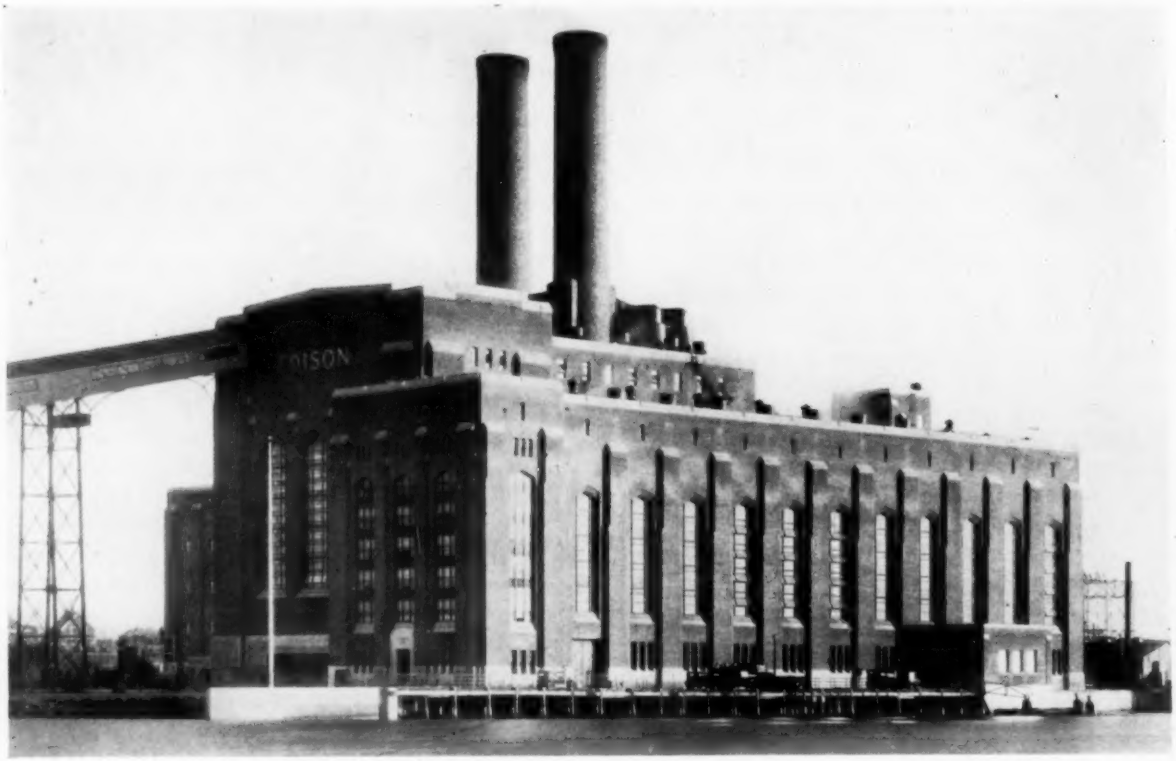
The use and the functions of modern power stations are totally different from those of any other buildings that have come down through history. There is nothing that has even remotely paralleled these structures in use or design. These modern buildings are intended to house huge machines and few people, to protect from the elements forces that are stupendous and superhuman. Thus the scale of these buildings must be adapted to the mechanical equipment, to machines which sometimes require a clear room height of 100 feet; to machines, some parts of which require the use of cranes which can lift 300 tons; to other machines which are operating at extremely high pressure. There is a feeling of grandeur and of poetry and of beauty in the orderly assembly of this modern, efficient and economical equipment, and it acts as a stimulant and an inspiration to the designer of the structure which houses it.

A power plant should reflect the life of today, for it is designed to supply needs in that life, needs that never arose in any previous civilization. What decoration may be used must be planned to meet exactly the problems which they



Proposed Ultimate Development, Charles Leavitt Edgar Station, No. Weymouth, Mass.

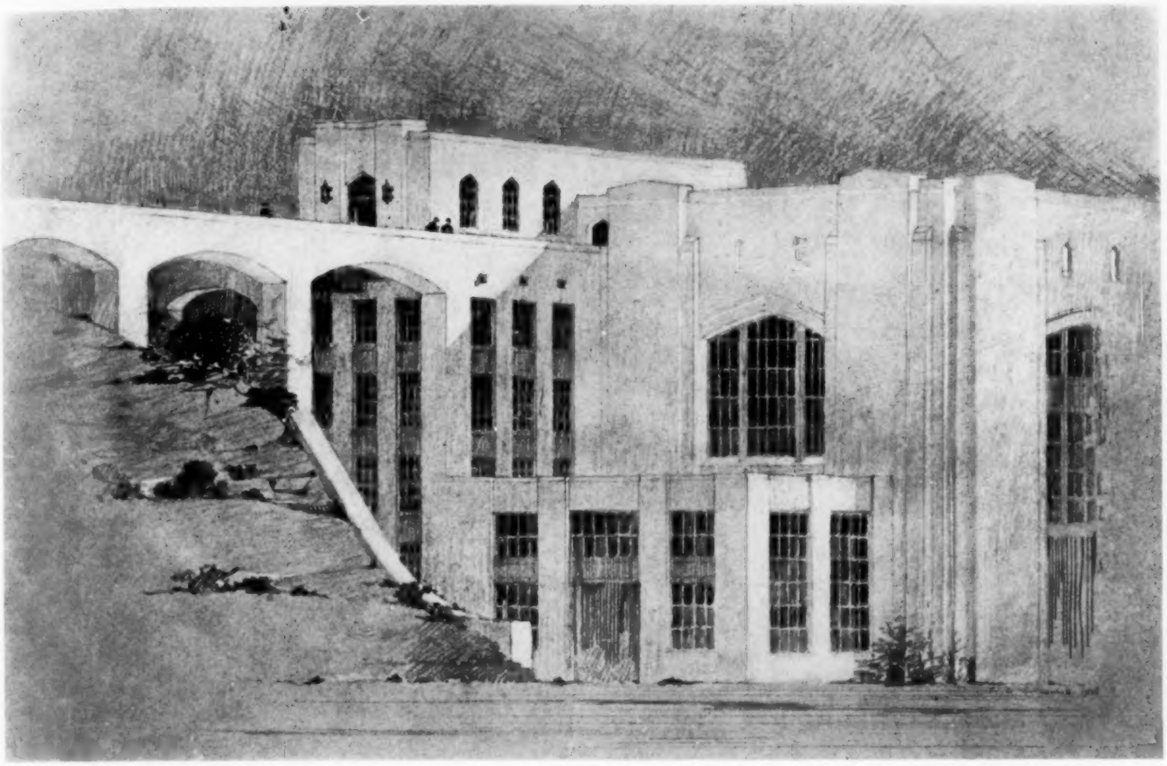
Edison Electric Illuminating Co. of Boston
Stone & Webster Engineering Corp., Engineers and Constructors
Bigelow & Wadsworth, Consulting Architects



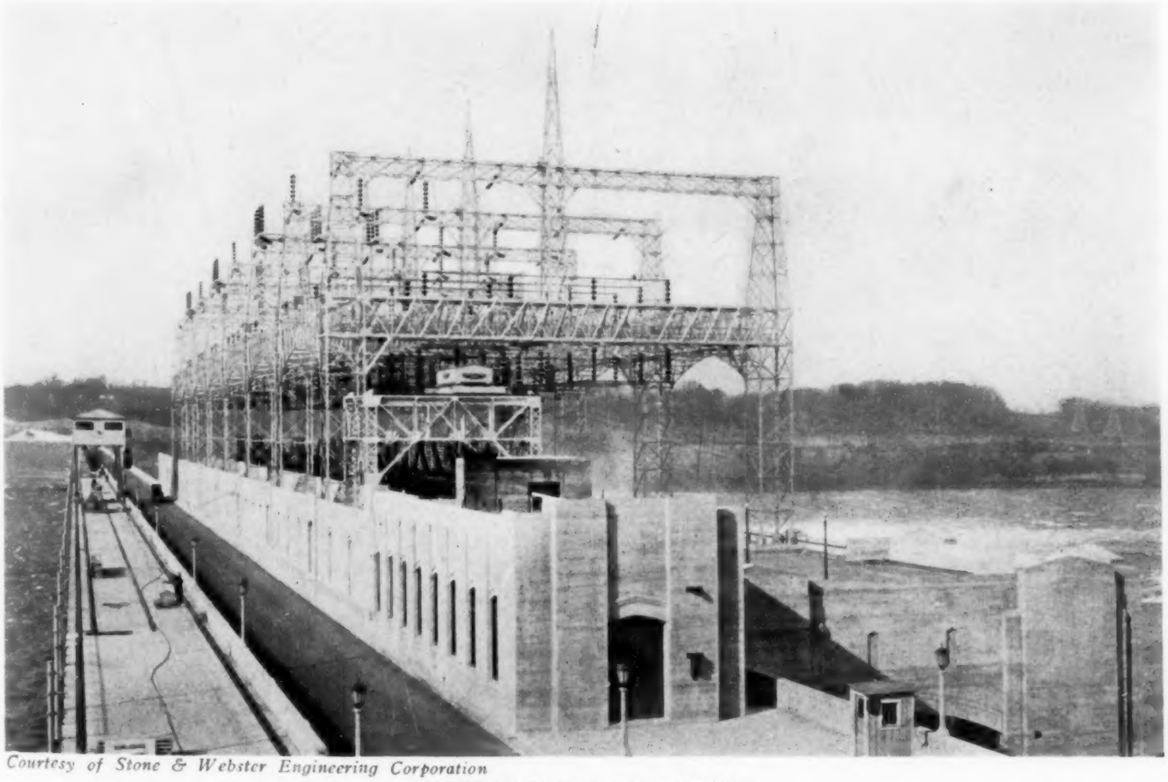
GENERAL VIEW

SWITCH HOUSE

CHARLES LEAVITT EDGAR STATION, NO. WEYMOUTH, MASS.
EDISON ELECTRIC ILLUMINATING CO. OF BOSTON
STONE & WEBSTER ENGINEERING CORP., ENGINEERS AND CONSTRUCTORS
BIGELOW & WADSWORTH, CONSULTING ARCHITECTS



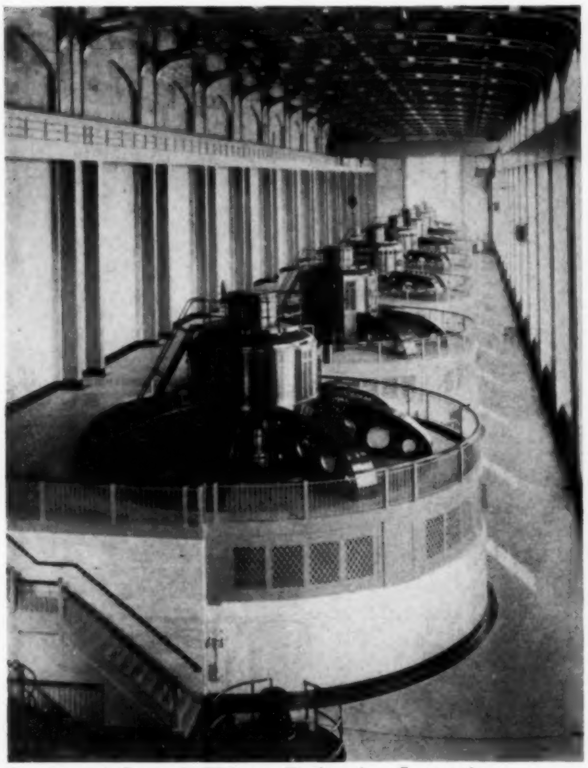
PERSPECTIVE STUDY OF OFFICE BAY



Courtesy of Stone & Webster Engineering Corporation

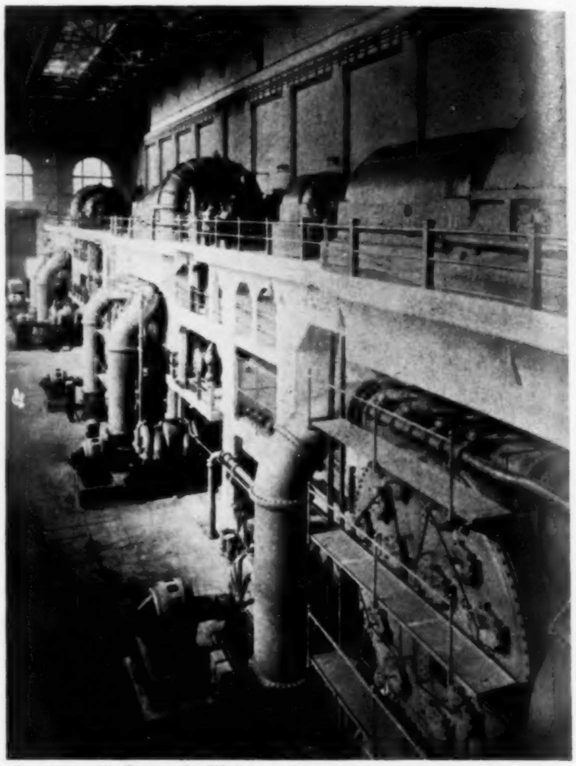
MAIN ENTRANCE AT HIGHWAY

HYDRO ELECTRIC DEVELOPMENT, SUSQUEHANNA POWER CO., CONOWINGO, MD.



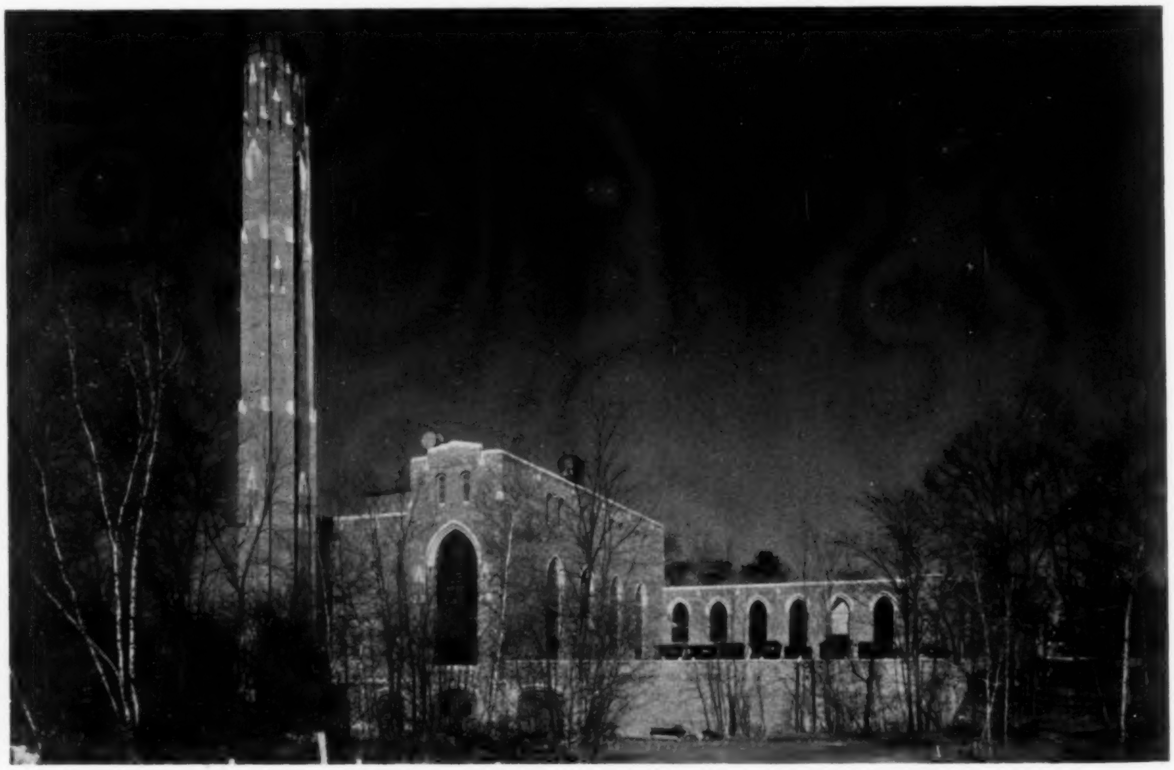
Courtesy of Stone & Webster Engineering Corporation

INTERIOR OF GENERATOR ROOM, HYDRO ELECTRIC DEVELOPMENT, SUSQUEHANNA POWER CO., CONOWINGO, MD.



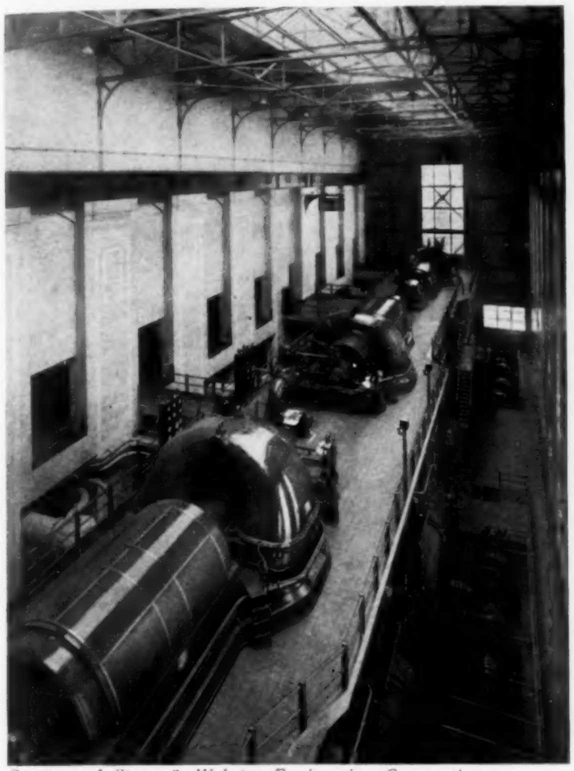
Courtesy of Stone & Webster Engineering Corporation

INTERIOR OF TURBINE ROOM, STEAM PLANT NO. 2, SOUTHERN CALIFORNIA EDISON CO., LONG BEACH, CAL.



STACK HOUSE, ST. PAUL'S SCHOOL, CONCORD, N. H.

DAY & KLAUDER, ARCHITECTS



Courtesy of Stone & Webster Engineering Corporation

TURBINE ROOM, CHARLES LEAVITT EDGAR STATION, NO. WEYMOUTH, MASS.
EDISON ELECTRIC ILLUMINATING CO. OF BOSTON

Courtesy of Stone & Webster Engineering Corporation

INTERIOR OF BOILER ROOM, NECHES POWER STATION
GULF STATES UTILITIES CO., BEAUMONT, TEX.

Courtesy of Stone & Webster Engineering Corporation

NECHES POWER STATION, GULF STATES UTILITIES CO., BEAUMONT, TEX.

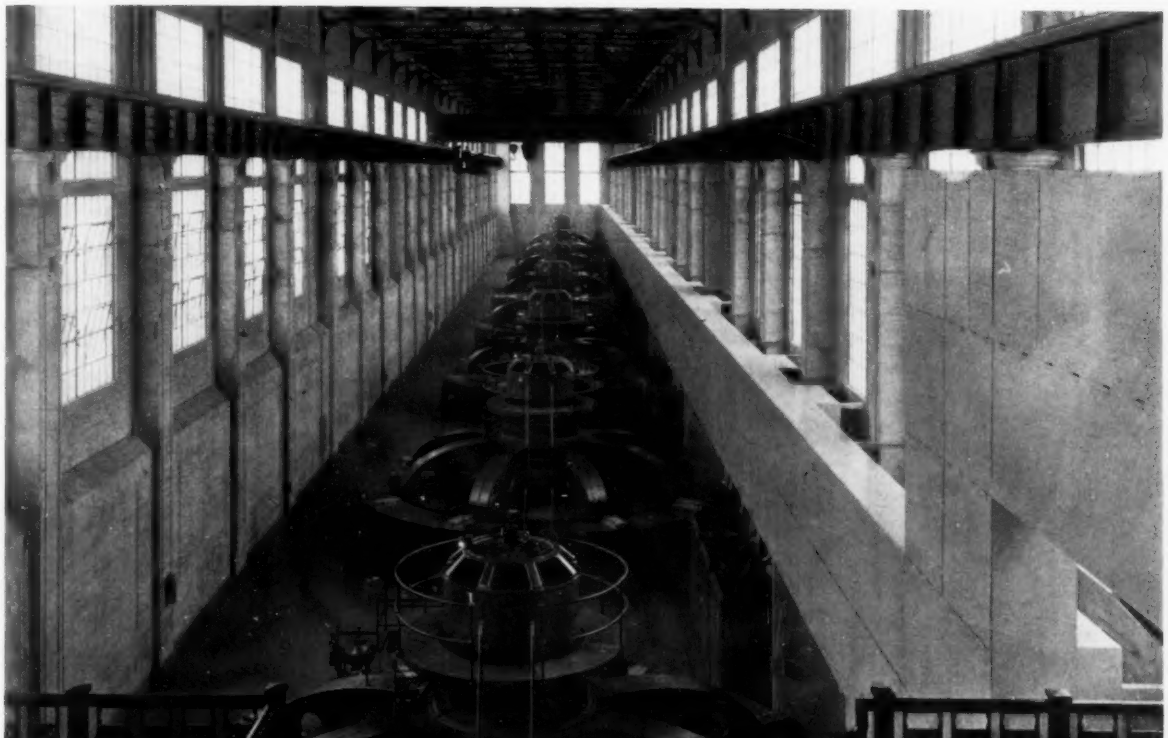
Courtesy of Stone & Webster Engineering Corporation

TWIN CITIES HYDRO ELECTRIC PLANT, FORD MOTOR COMPANY, ST. PAUL

Courtesy of Stone & Webster Engineering Corporation

TWIN CITIES STEAM PLANT, FORD MOTOR CO., ST. PAUL

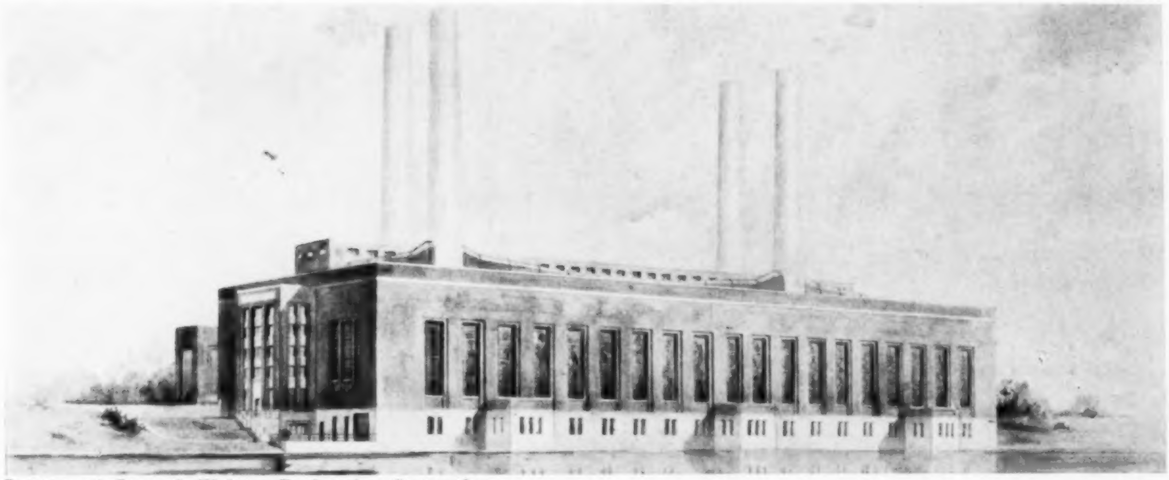
EXTERIOR VIEW



INTERIOR, OHIO FALLS HYDRO STATION, LOUISVILLE GAS & ELECTRIC CO.
BYLLESBY ENGINEERING & MANAGEMENT CORPORATION, ENGINEERS

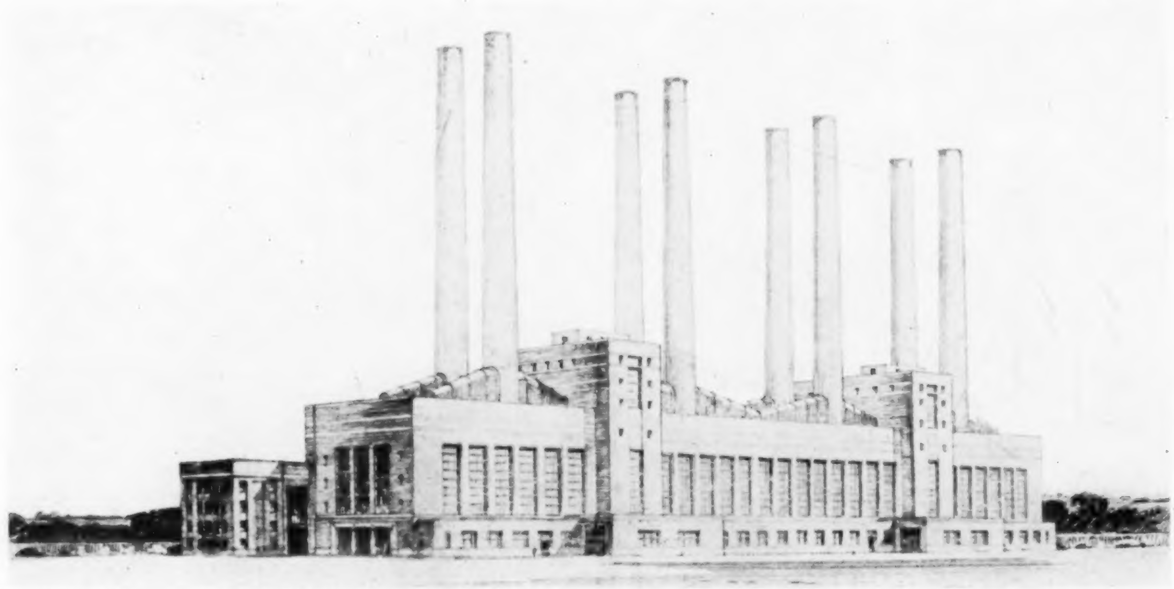
Courtesy of Stone & Webster Engineering Corporation

SOMERSET POWER STATION, MONTAUP ELECTRIC CO., SOMERSET, MASS.



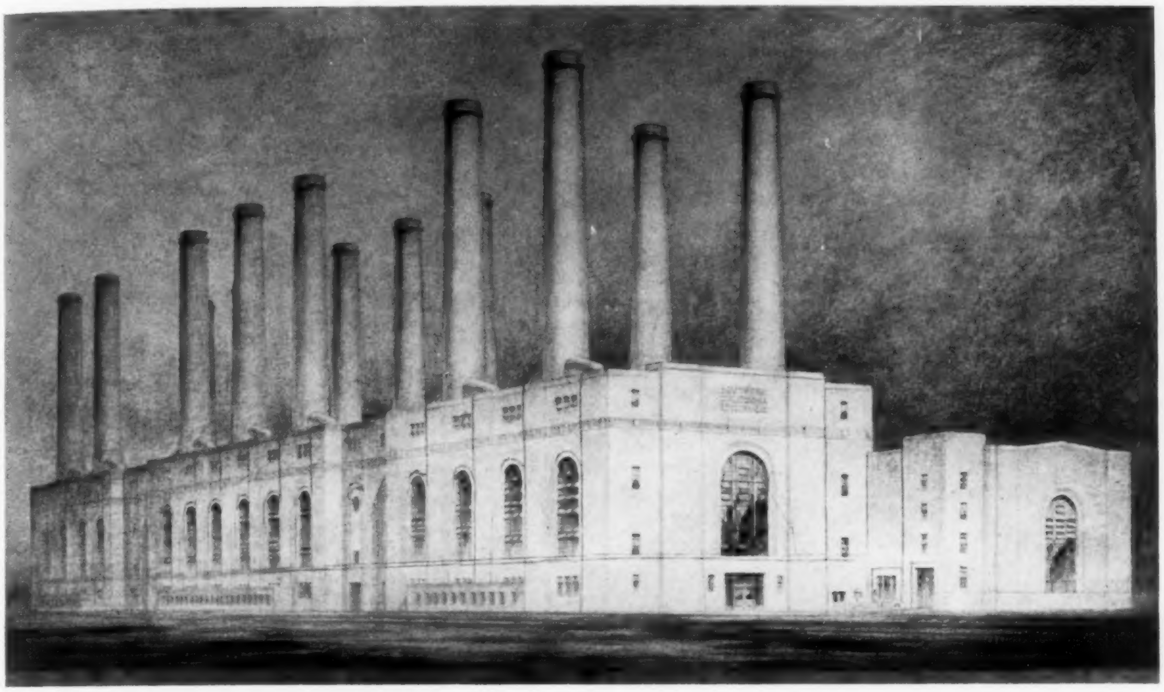
Courtesy of Stone & Webster Engineering Corporation

PERSPECTIVE OF ULTIMATE DEVELOPMENT, SOMERSET POWER STATION, MONTAUP ELECTRIC CO., SOMERSET, MASS.

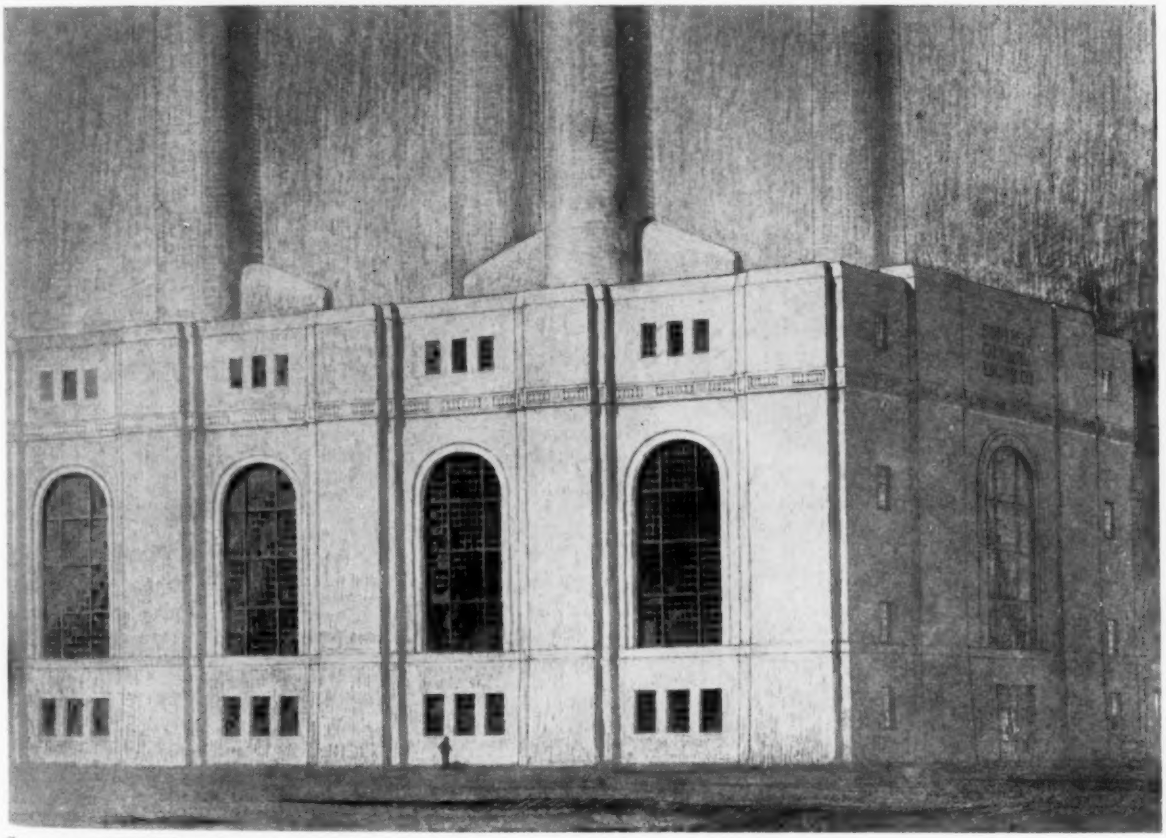


Courtesy of Stone & Webster Engineering Corporation

PERSPECTIVE OF ULTIMATE DEVELOPMENT, POWER STATION, LUZERNE COUNTY GAS & ELECTRIC CORPORATION, HEMLOCK CREEK, PA.



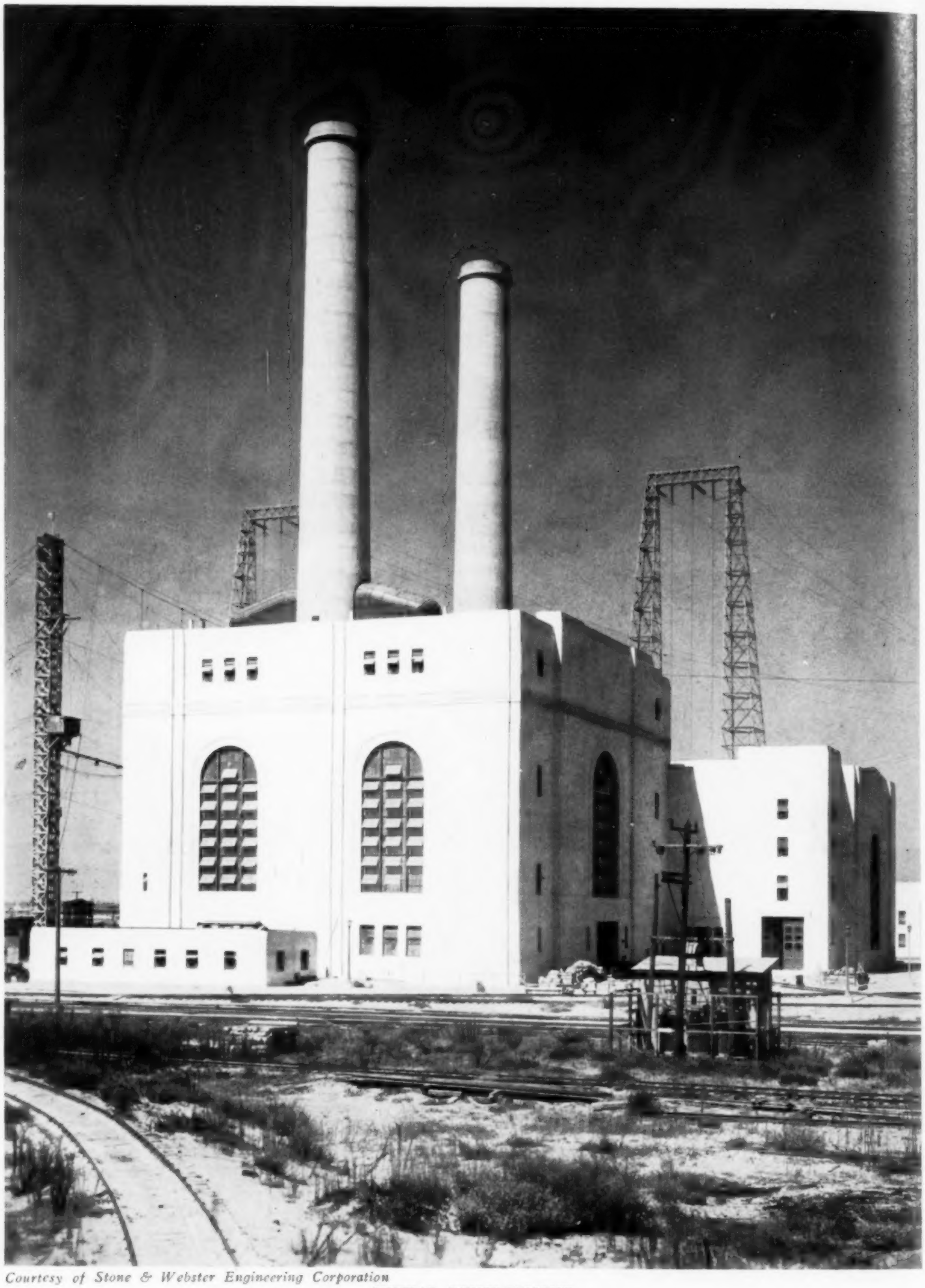
PERSPECTIVE OF ULTIMATE STATION



Courtesy of Stone & Webster Engineering Corporation

STUDY OF EXTERIOR DETAILS

STEAM PLANT NO. 3, SOUTHERN CALIFORNIA EDISON CO., LONG BEACH, CAL.



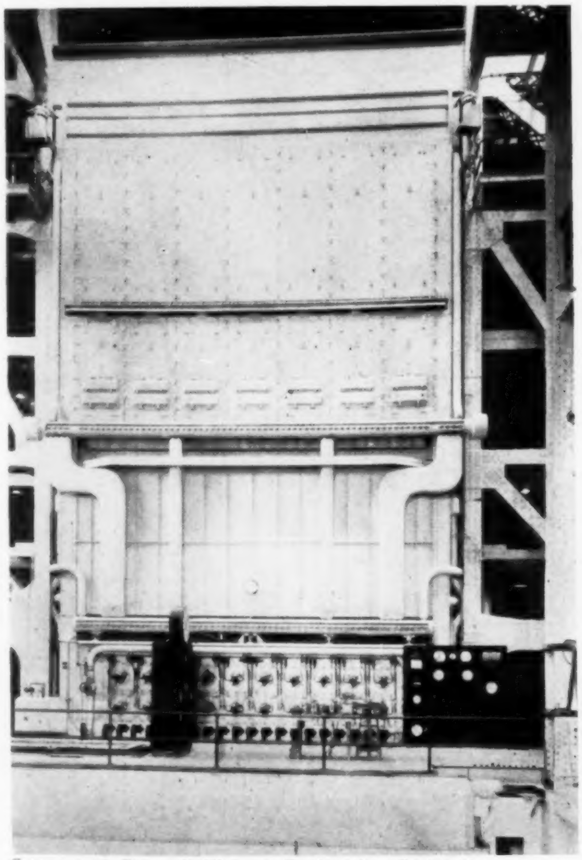
Courtesy of Stone & Webster Engineering Corporation

INITIAL DEVELOPMENT

STEAM PLANT NO. 3, SOUTHERN CALIFORNIA EDISON CO., LONG BEACH, CAL.

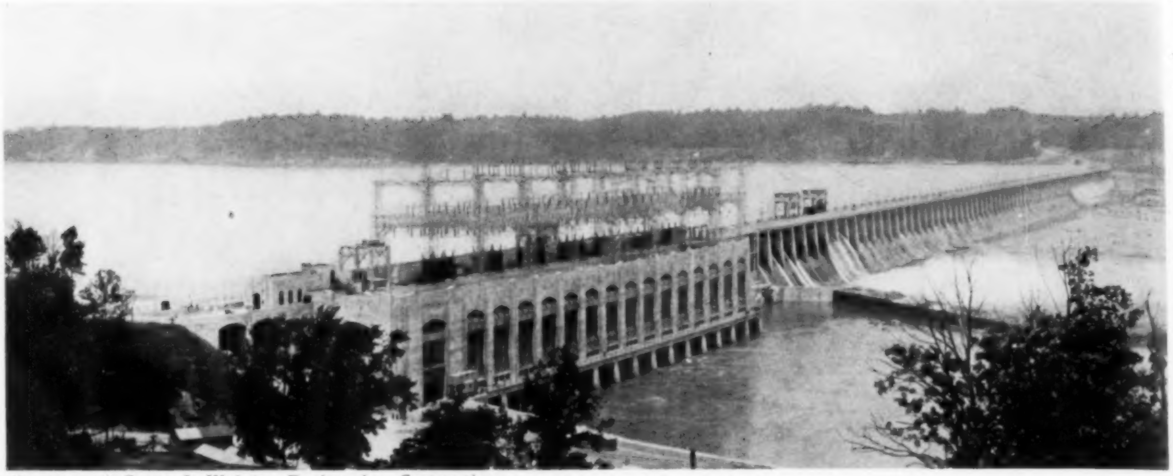
Courtesy of Stone & Webster Engineering Corporation
BOILER PLANT, FIRESTONE TIRE & RUBBER CO., LOS ANGELES

Courtesy of Stone & Webster Engineering Corporation
POWER STATION, LUZERNE COUNTY GAS & ELECTRIC CORP., HEMLOCK CREEK, PA.



Courtesy of Stone & Webster Engineering Corporation
INTERIOR OF BOILER ROOM, STEAM PLANT NO. 3, SOUTHERN CALIFORNIA EDISON CO., LONG BEACH, CAL.

POWER PLANT FOR BROWN & BIGELOW, ST. PAUL
TOLTZ, KING & DAY, INC., ARCHITECTS & ENGINEERS



Courtesy of Stone & Webster Engineering Corporation
Hydro Electric Development, Susquehanna Power Co., Conowingo, Md.

present. "True architecture is construction carried to the highest point of development without the necessary addition of any elements foreign to its own conditions of stability and strength. Structure cannot be elevated into the domain of art merely by the application of ornament." Decoration is no longer a need of this age as it was in the days before people could read and before there was much printing, for then decoration told a story, which is now told much better in other ways. We should depend today on mass, beauty of proportion, and relations of voids and solids together with texture and color to obtain the effects for which we are striving. The design then should be of the utmost simplicity in character. This likewise tends toward economy, which is an exceedingly important factor, for the money to build these stations comes from large numbers of people who expect to receive a return on their investment, while the cost of the light and power produced must be paid for by the great mass of the public who cannot afford to pay more than a reasonable price for the service they receive.

Besides simplicity of design, an attempt should be made to express strength,—that is power,—and where the limitations of the mechanical and structural designs are not too great, at times real beauty can be secured. Yet one of the deterring factors in obtaining beauty is the piecemeal fashion in which these stations must often be built. At the same time it necessarily influences the design of the whole, for the building must be chopped off at any point which will satisfactorily house the equipment then being installed, since the stations are designed merely to meet the load requirements for an estimated period of time. Similarly, it is practically impossible to anticipate the ultimate size of any given plant. The design of mechanical and electrical equipment is changing so rapidly, new principles are being discovered, new economies are being found,—that a station which is modern today may in a few years be entirely out of date, or it may be too small to contain newly designed equipment, thus demanding the establishment of a new plant, or the complete redesigning of the additions.

The dominating influence of mechanical and electrical features upon the architectural design should be apparent. The elements of this equipment must be related in the most advantageous manner to produce steam and electricity at the lowest cost. The design of the building must not interfere with the perfect coördination of turbine with condenser, of economizers and preheaters with the boilers, of atmospheric exhausts to go somewhere, and induced draft and exhaust fans which call for louvers many times larger than they should be for appearance, and cinder catchers that won't get under the roof; and then the loads of the structure and its equipment and its chimneys all carried in the beams and girders and columns do not leave much opportunity for design.

However, with all these limitations, the coöperation of the engineers and architects, with the hearty assistance of clients, is permitting definite advancement in the designing of power plants. That this is now being done is amply demonstrated in every part of the country. Countless excellent examples of such buildings are being constantly illustrated in the architectural publications, and not a few are shown in this number of THE ARCHITECTURAL FORUM, devoted as it is exclusively to industrial structures. Mere size of itself possesses but little interest, but when to size there are added fine and simple lines and well studied proportions, and when use has been made of appropriate materials, there comes a grace or rhythm which constitutes beauty in a high degree.

ARCHITECT VERSUS ENGINEER

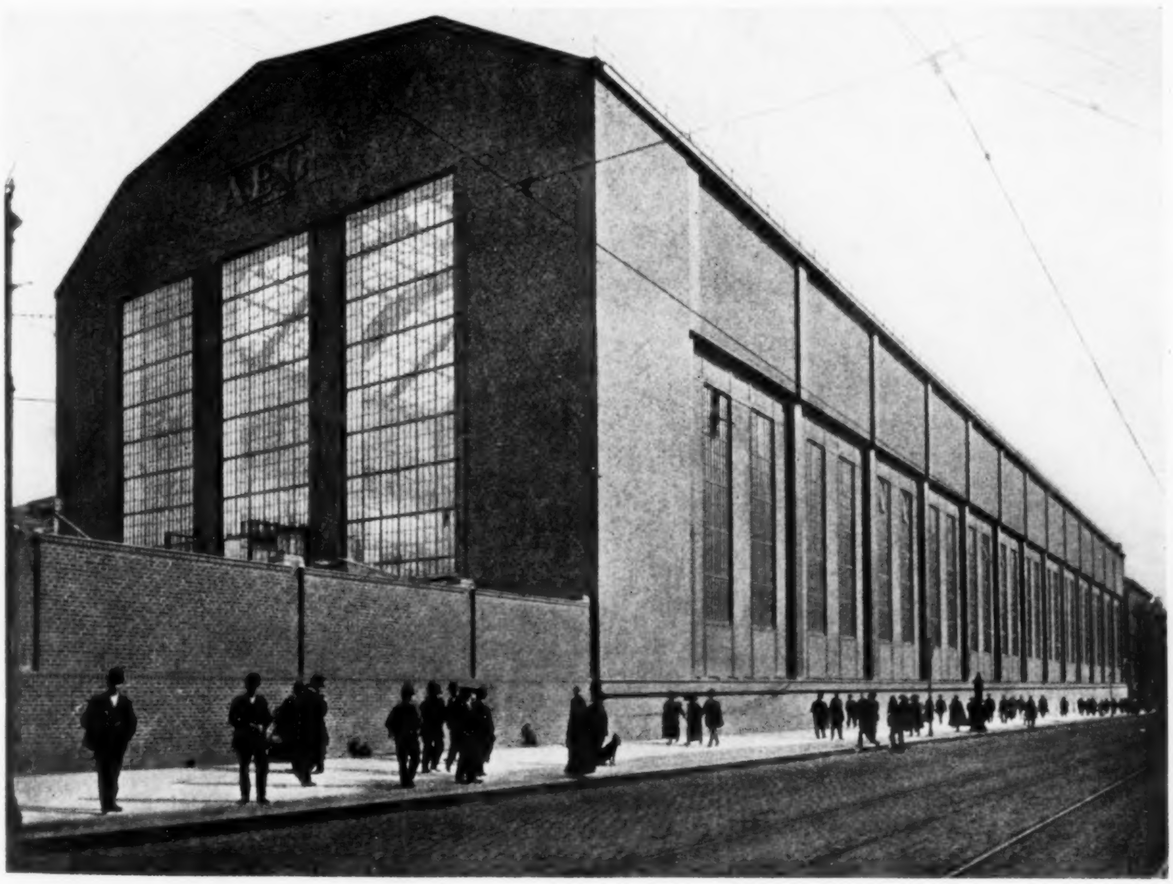
BY

SHEPARD VOGELGESANG

BEING A SUMMARY OF THE BOOK "ARCHITEKT UND INGENIEUR" BY FRITZ SCHUPP AND MARTIN KREMMER, BERLIN, 1929

OCCASIONALLY the American architect is challenged by the opportunity to do purely industrial work. More often an engineer alone is employed, industrial building being considered by some beyond the compass of the architect's training. The point of view often held by engineers and manufacturers is that an architect is all right if you want to dress things up, but otherwise why employ one? It is for this reason that an opportunity to do industrial work comes as a challenge to the architect. This attitude,—that an architect is hired to put frippery on an otherwise complete structure,—strikes at the very foundations of the architect's service. Architecture is not millinery or, as the Germans say, "hair dressing"; it is the art and science of orderly arrangement plus a sense for beauty.

The architectural sense for beauty is not bound up in ornament. A building may be bare and yet architecturally beautiful through proportions, rhythm and material. As the degree of sensibility of the architect to proportion, rhythm and material is high, so high will the architectural worth of the building be. It is hard to find in America buildings more beautiful than some early colonial work which often presents only these primal elements of architectural beauty unornamented. Architecture is more than right structure, it is building related to human needs, the need for interest in arrangement, the right degree of uniformity, the right break in monotony, the friendly climate indoors supplanting the hostile elements outside. The difference between planned architecture and mere building is like the difference between the movements of a trained and an untrained body. The difference between a skilled architect's management of building stuff and the mere use of the same materials is much the same as the difference between the polished brilliant and the uncut gem. At every



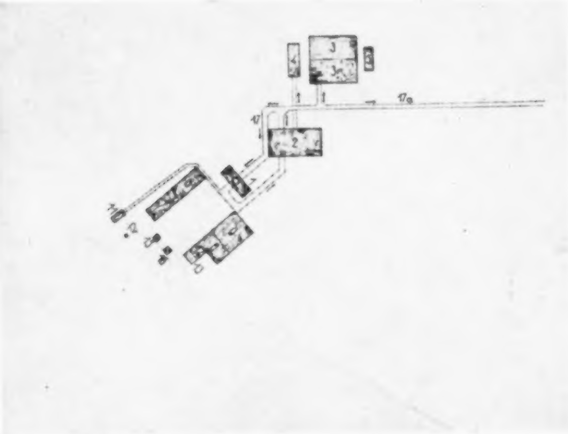
Montagehalle. A. E. G. Company, Berlin

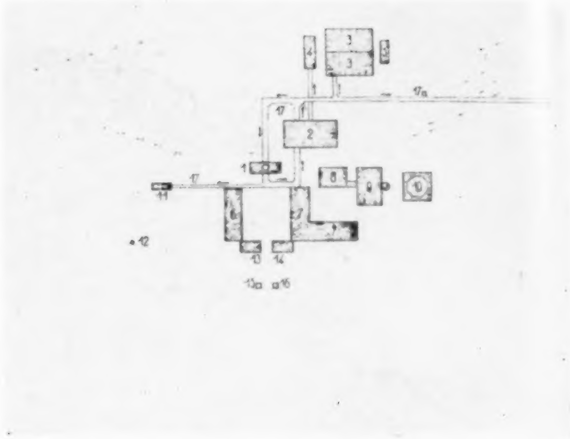
Peter Behrens, Architect

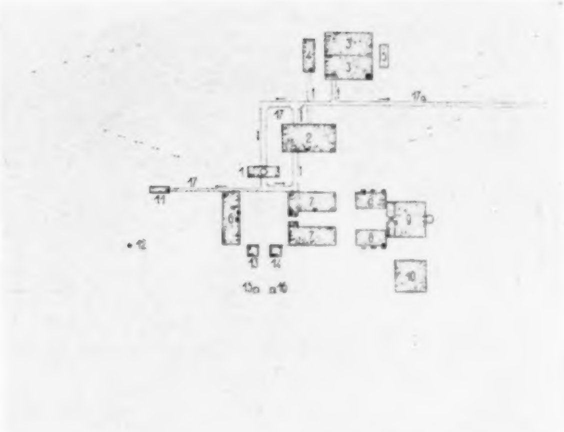
MAIN BUILDING, A. E. G. COMPANY, BERLIN
PETER BEHRENS, ARCHITECT

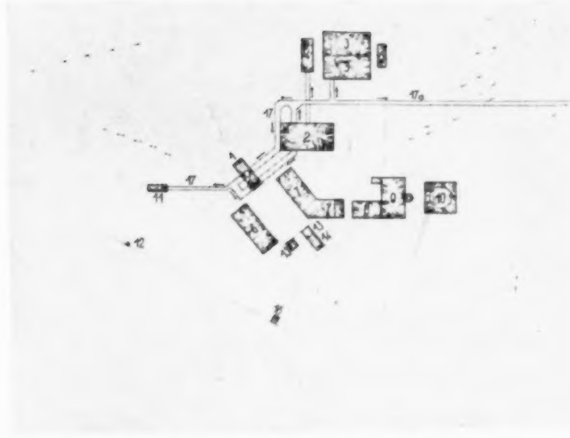
TURBINEN HALLE, A. E. G. COMPANY, BERLIN
PETER BEHRENS, ARCHITECT

FACTORY AT FRANKFORT
PETER BEHRENS, ARCHITECT







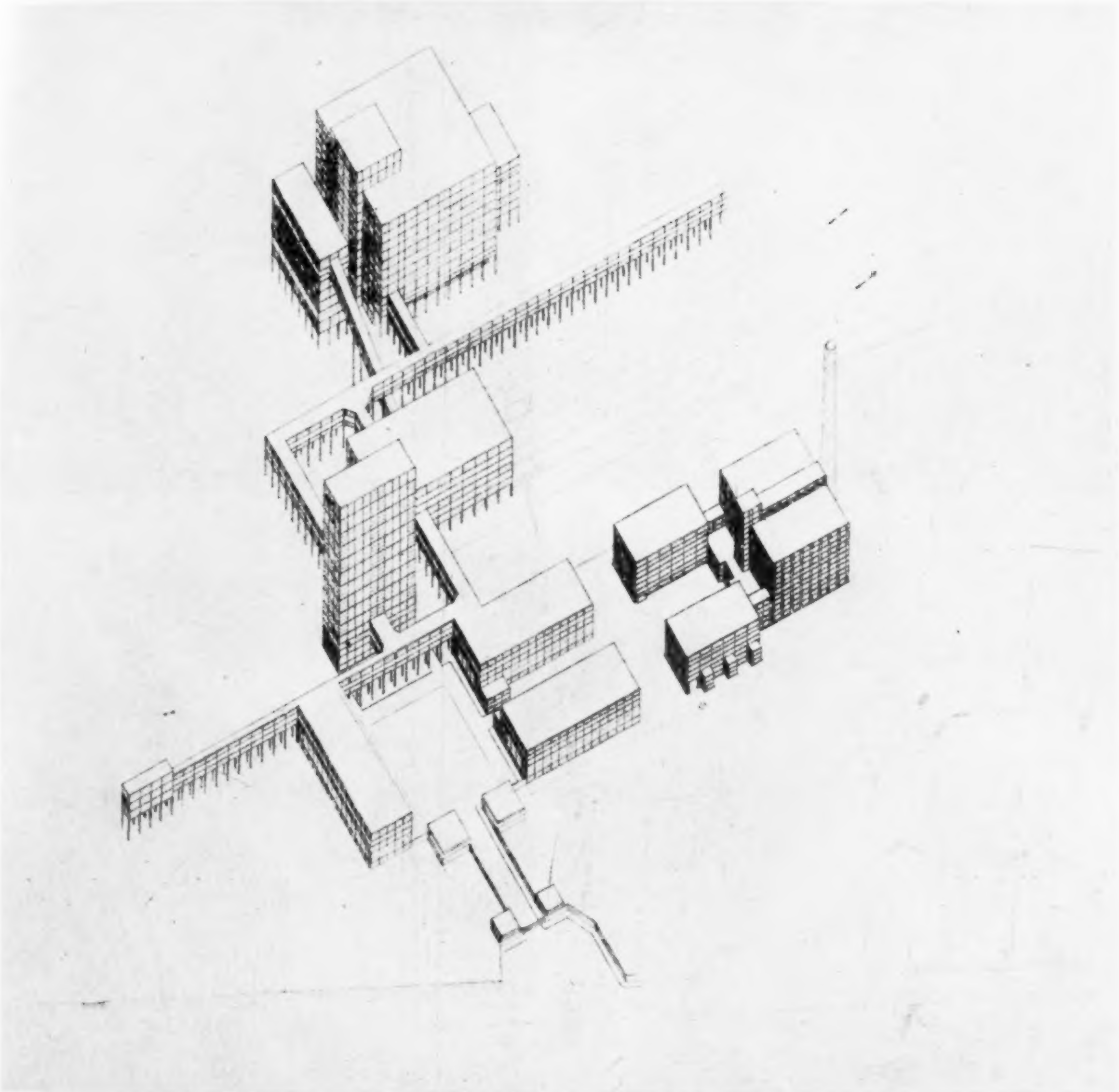


Studies to Secure Symmetrical Grouping of Colliery Buildings

point the architect touches some human need deeper than mere structure, or else he fails in rendering the service expected of an architect.

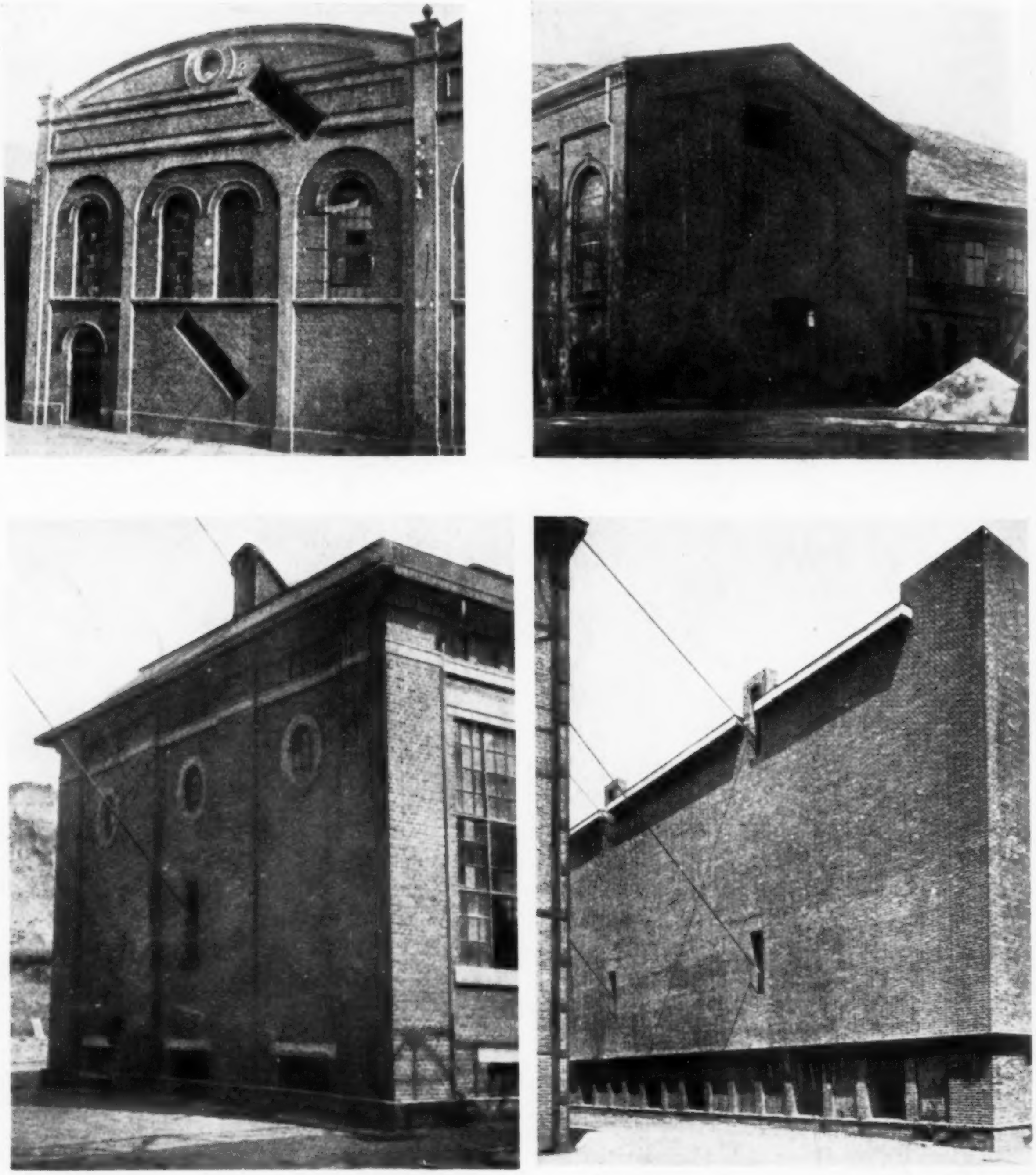
The source of most of the illustrations to this article is a book fresh from Germany with the trenchant title "Architect *versus* Engineer or Architect and Engineer." It is written by two graduated engineers, Mr. Schupp and Mr. Kremmer, who are, besides, architects. The field of discussion covers industrial work of the most outspokenly utilitarian kinds,—collieries, machine shops, factories, coke ovens and gas tanks. Formerly in Europe as in America, architects has more powerful tools than curling irons and dustrial buildings if they were hired at all. Sometimes the owner felt that his building could stand a little prinking after the engineer had the rough work well in hand. It is generally conceded that Peter Behrens in Europe first showed that the architect in industrial buildings has more powerful tools than curling irons and strings of beads. His *Turbinen Halle* and other buildings in Berlin awakened architectural sense to the grandeur of industry. Tony Garnier repeated the same service for France in his *Abattoirs de la Mouche* at Lyons.

The importance of industrial expansion after the war placed a new emphasis on industrial building. Here was something in the overturned social scheme which had at least the reality of a concrete service. The impulse was to dignify this service, and, following the precedent set by Behrens, architects of high standing found increasing interest in industrial work. Such buildings as Behrens's dye works at Hochst am Main



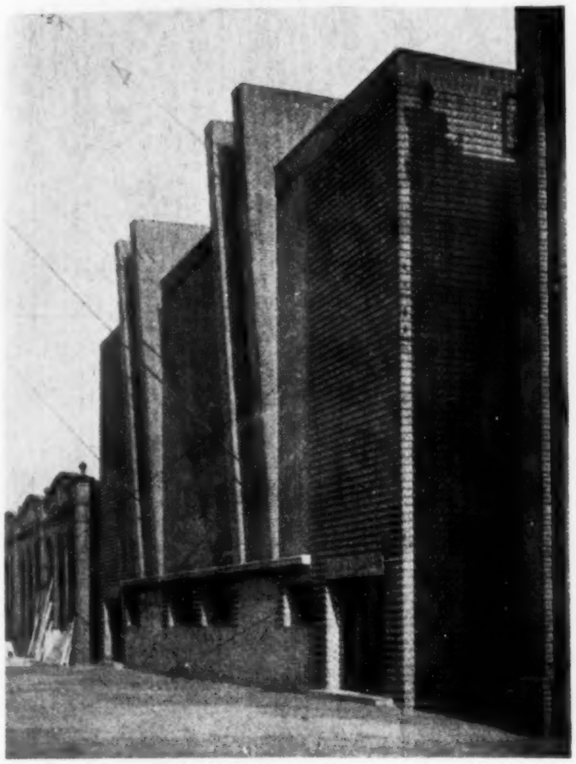
Sketch of Final Grouping of Colliery Buildings. Page 65, "Architect vs. Engineer"

(Illustration Moderne Bavformen, page 331), Alfred Fischer's power plant at Cologne, and Erich Mendelsohn's hat factory near Berlin illustrate the success with which architects entered this field. An entire school of architects, in fact, was carried away by the glories of the completely utilitarian. For some, architecture and the product of the engineer became the same. Any work of engineering possessed final beauty because it was the result of function frankly expressed. Of great and often healthy influence, this idea is gradually becoming modified. Too many buildings have been built by engineers with all the elements in correct sequence, built of appropriate materials, and yet possessing no perceptible coherence. Conduits will plunge through raw looking gaps in walls, steel skeletons brandish tanks through roofs, and the whole tatterdemalion succession of brick, steel, concrete and corrugated iron produces too often the effect of mere brutality. The day of the old architect who built a power station on the proportions of the Petit Trianon and then allowed this structure to be pierced by ventilators, conveyor belts and ærial gangways, is also happily past. The architect is the man trained in the proportioned arrangement of space; it is he who takes the engineer's ruder sequences and arranges them in order. This order is not that of a regiment of soldiers commanded to a scheme but the result of an individualistic study of the elements composing the whole. Certain elements form natural groups, which again lead on to other groupings of kindred functions. The whole is



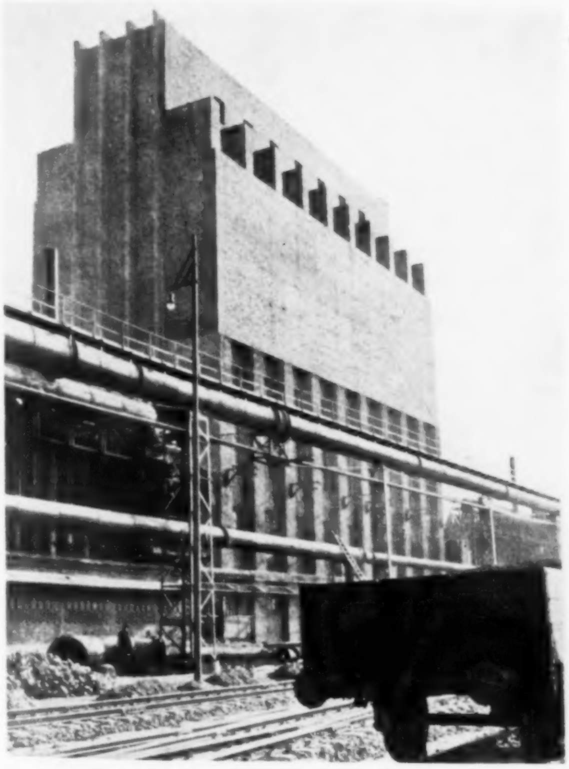
Illustrations, Page 7 of "Architect vs. Engineer," Showing Right and Wrong Treatments of Power Cables

organized with an eye to presenting all of the parts as favorably as possible with as much space about them and between them as can be had, the while a sense of the groups forming one whole is maintained. The development from an engineering solution of a problem to an architectural arrangement is shown in illustrations 1, 2, 3, 4 and 5 on pages 61, 62 and 63 of "Architect *vs.* Engineer." The finished building mass is on page 65. The subject of the layout is a colliery. The road and railroad approach remain constant factors. The chief elements are: shaft house (1), with tower hoists, power and boiler houses (8, 9), (7) work shops, (6) executive, (3) washing, (2) shipping; (17a) leads to old mines. While it is plain that the architect has greatly increased the amount of foundation work, it can also be definitely asserted that the final scheme shows more organic arrangement and gains in clarity, in wholesomeness, and in

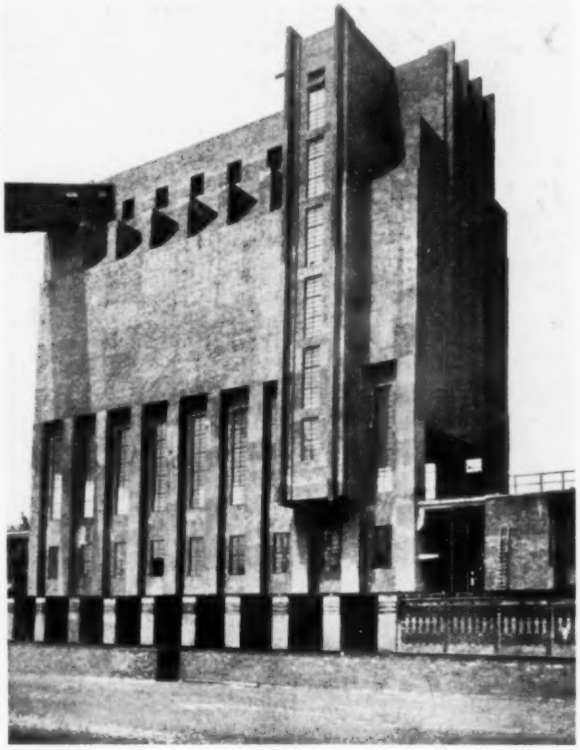


FROM PAGE 9, "ARCHITECT VS. ENGINEER," SHOWING TREATMENT OF A CABLE WALL—ENTRANCES

FROM PAGE 11, "ARCHITECT VS. ENGINEER," ILLUSTRATING AN EXAMPLE OF A MODERN ELEVATOR SHAFT



FROM PAGE 17, "ARCHITECT VS. ENGINEER," SHOWING SYMMETRICAL COAL ELEVATOR



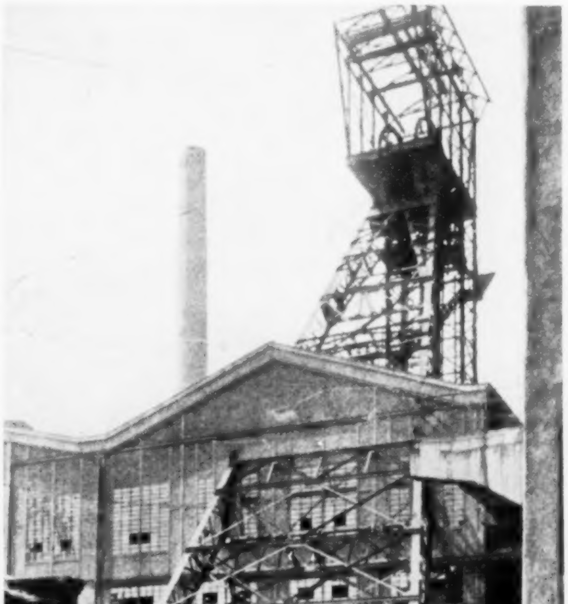
FROM PAGE 14, "ARCHITECT VS. ENGINEER," ILLUSTRATING TREATMENT OF EXTERIOR STAIR SHAFT

FROM PAGES 12 AND 14, "ARCHITECT VS. ENGINEER," ILLUSTRATING VERTICAL EXPRESSION OF STAIR AND ELEVATOR SHAFTS

FROM PAGE 25, "ARCHITECT VS. ENGINEER." IRON WORKS SHOWING STEEL CONSTRUCTION THROUGH BRICK WALLS

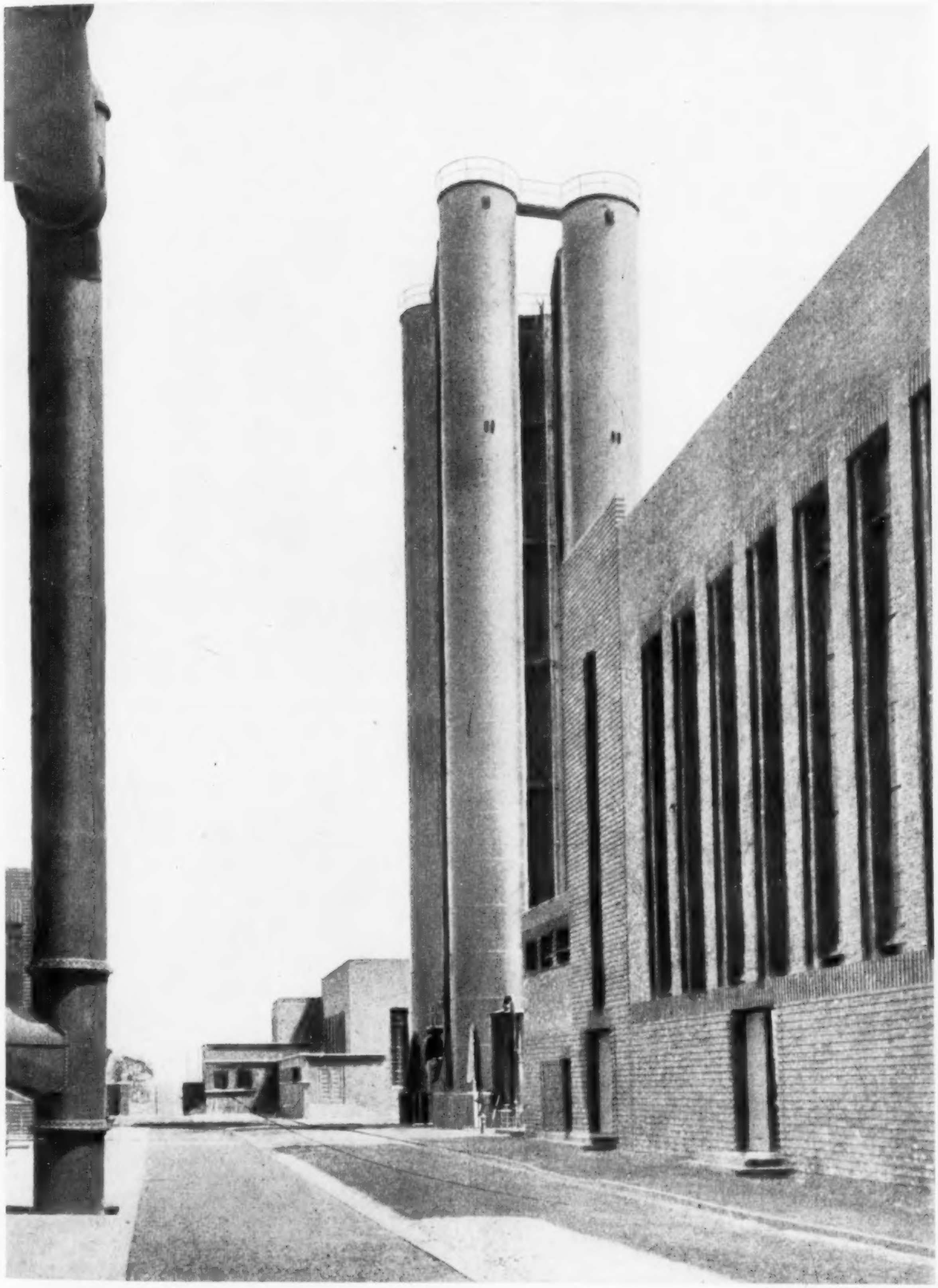
FROM PAGE 26, "ARCHITECT VS. ENGINEER." BOILER HOUSE SHOWING STEEL CONSTRUCTION THROUGH BRICK WALLS


FROM PAGE 29. "ARCHITECT VS. ENGINEER." HARMONIOUS TREATMENT OF STEEL SUPERSTRUCTURES ON TOPS OF SOLID BUILDINGS

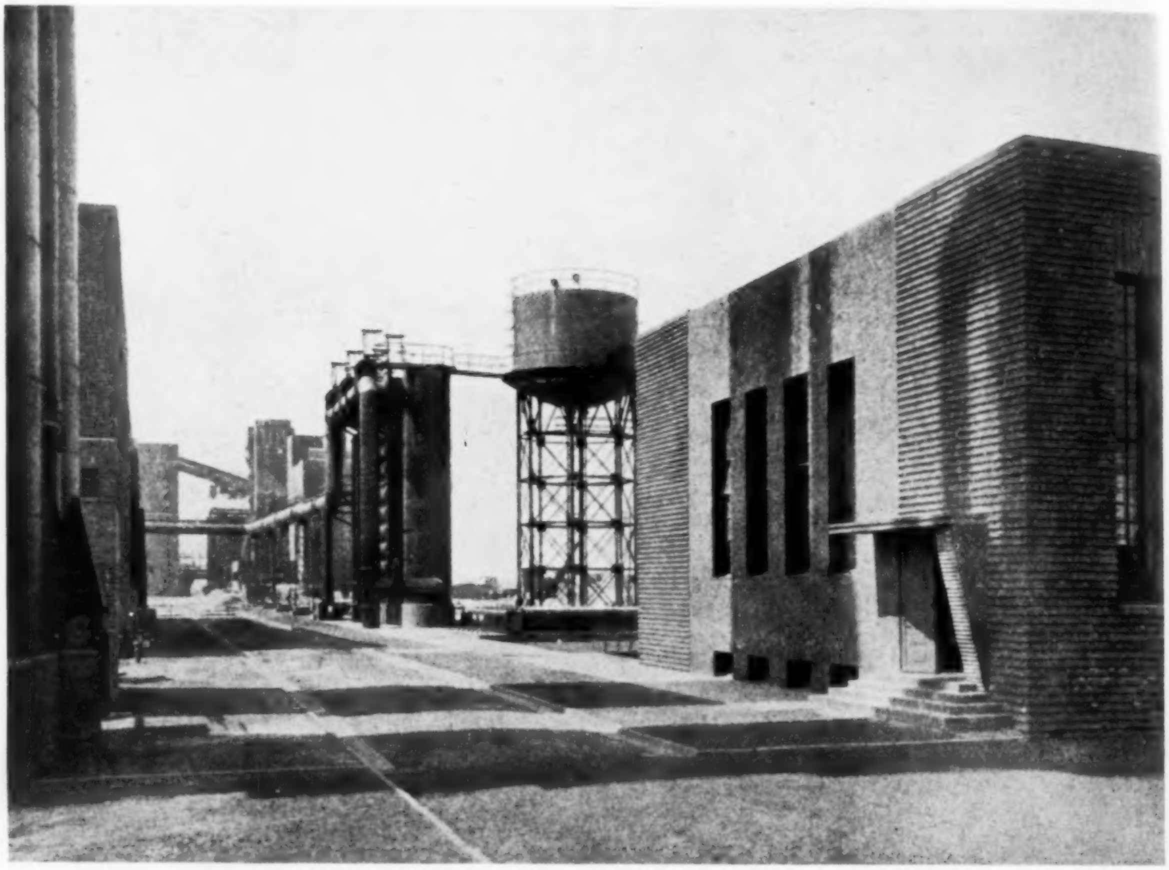



FROM PAGE 31 "ARCHITECT VS. ENGINEER." IMPROPER TREATMENTS OF OPEN STEEL SUPERSTRUCTURES ON TOPS OF SOLID BUILDINGS

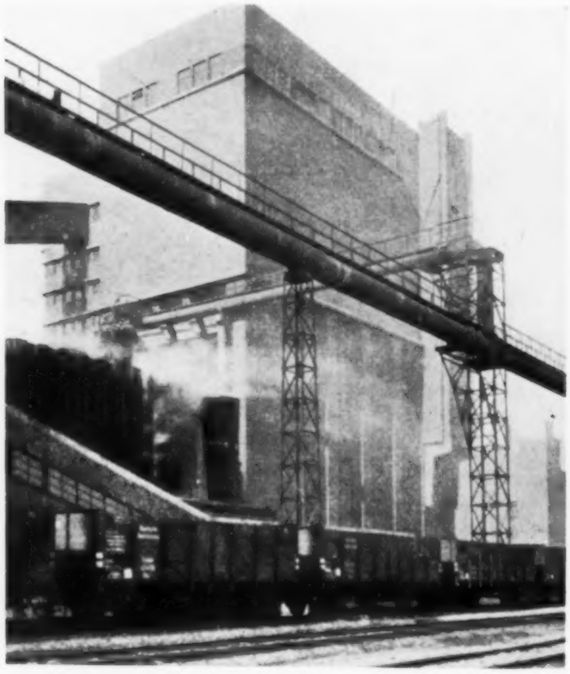
FROM PAGE 33, "ARCHITECT VS. ENGINEER." PROPER INCORPORATION OF OPEN STEEL SUPERSTRUCTURES IN THE BUILDING SCHEME THROUGH TOWER BASES

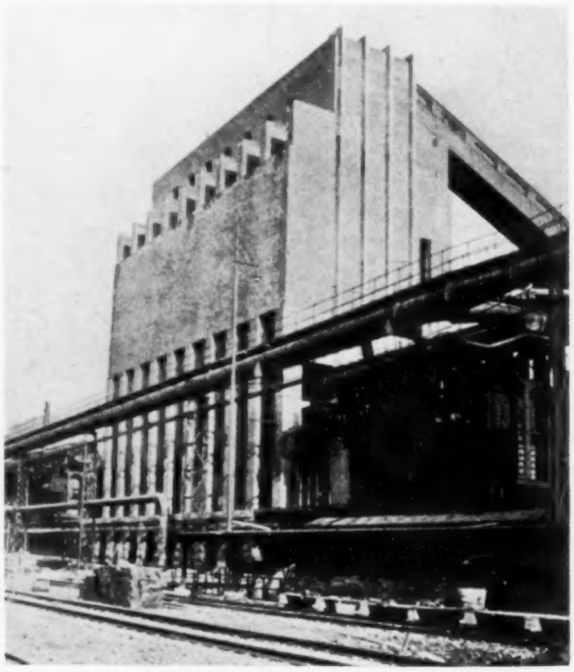


FROM PAGE 39, "ARCHITECT VS. ENGINEER," SHOWING ORDERLY ARRANGEMENT OF STANDPIPES AND BUILDINGS

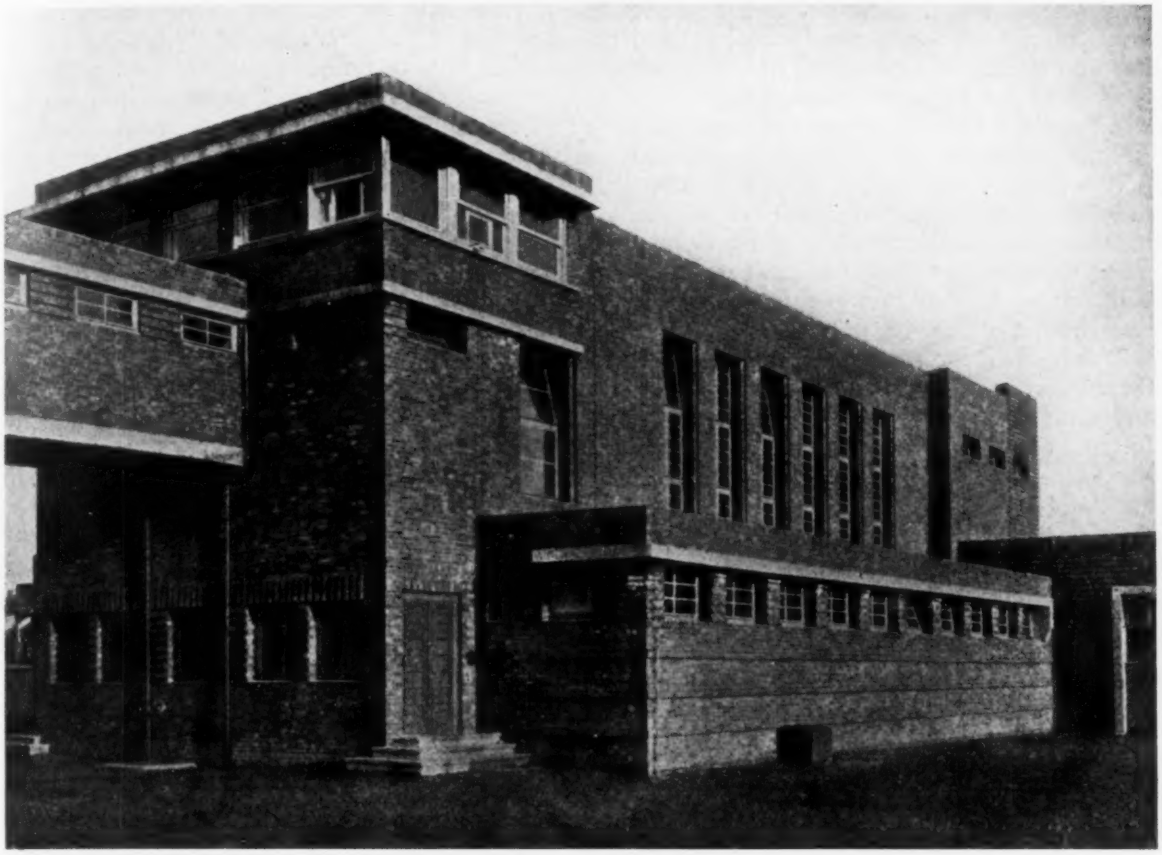


FROM PAGE 36, "ARCHITECT VS. ENGINEER," SHOWING ORDERLY ARRANGEMENT OF TANKS, SMOKE STACKS, STANDPIPES AND BUILDINGS

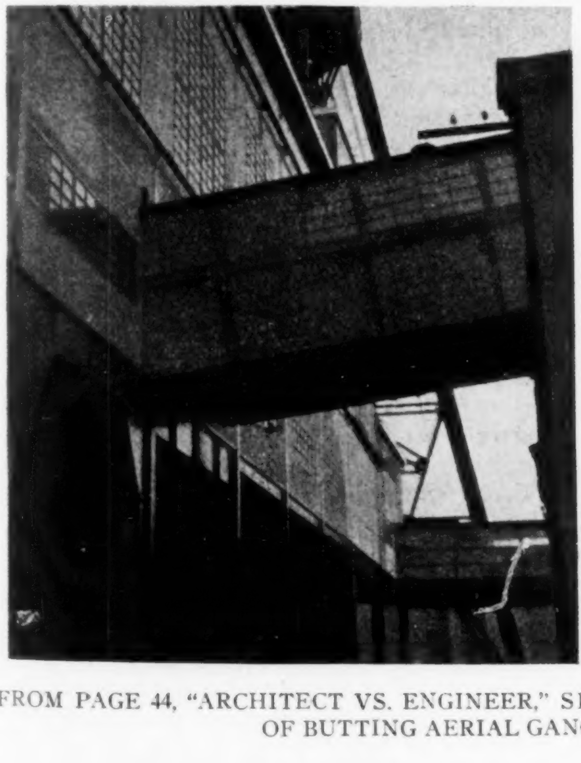


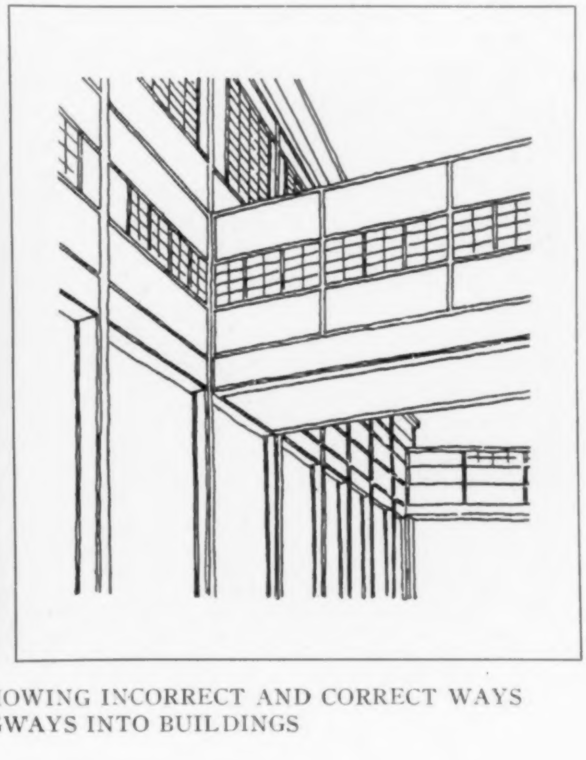


FROM PAGE 42, "ARCHITECT VS. ENGINEER," SHOWING AERIAL CONDUITS UTILIZED TO BIND BUILDING GROUPS TOGETHER



FROM PAGE 45, "ARCHITECT VS. ENGINEER," SHOWING CORRECT WAY OF TYING AN AERIAL GANGWAY INTO A BUILDING





FROM PAGE 44, "ARCHITECT VS. ENGINEER," SHOWING INCORRECT AND CORRECT WAYS OF BUTTING AERIAL GANGWAYS INTO BUILDINGS

spatial composition. The writer has previously inveighed against the extreme school of modernists who would avoid the "court of honor" scheme because of the literary associations of the word when such a scheme serves the purposes of a clear arrangement for units and useful connection between them. He is of the opinion that monumentality is an admissible expression of industrialism and that there are no monuments more appropriate to this age than its industrial buildings,—provided that the monumentality is real and not of the improved "Trianon" variety.

This search for reality of expression forms the subject matter of most of the illustrations and attains its end for the most part successfully. Page 7 of "Architect *vs.* Engineer" illustrates the raw and gradually improved treatment of a cable power belt. Page 9 its fully expressed function. Pages 10, 11 and 12 illustrate the clear, vertical expression of stair and elevator shafts.

Pages 18 to 28 illustrate the use of brick. In buildings where resistance against coal-gas laden atmosphere, smoke and general industrial impurity of the air is imperative, brick is the ideal material. Its quiet, warm, unified color binds buildings of diversified purposes into harmony. The ease with which the variation of a pattern can be introduced through modulation of surface and color to break monotony is one of its greatest assets. Its chief disadvantage is that it presents too fixed an appearance,—too solid a monumentality. In buildings filled with machinery a certain freedom for the walls to vibrate is necessary. The changing needs of modern industry make easy extension or alteration of the building one of its desirable properties. These considerations are not met by brick used by itself, but when used to fill between exposed steel framework it immediately meets the practical needs and gives a visual impression of the fulfillment. Since the modern building is really only a screen to regulate light and to protect against weather and temperature, this membrane-like structure, resembling half-timbering, gives a perfect expression of both structural facility and functional reality. When, as in the engine houses on page 23 and the iron works on page 25 and the boiler house page 26, windows and steel framework are in one visibly related scheme, a close unity or harmony in expression of the building elements is attained.

The next feature of industrial work to be discussed is the open steel superstructure on top of the solid building. Page 29 of "Architect *vs.* Engineer" shows the development of such features toward harmony with the solid structure beneath through the use of solid plate girders. Page 31 illustrates the accidental, uncoördinated location of such superstructures and 33 their proper incorporation in the building scheme through tower bases.

Page 36 of the same work illustrates an orderly arrangement of diverse elements such as standpipes, water tanks and solid buildings. Because of well proportioned planning and wise placing, these various types of construction count each for its own function without noisiness. It is sometimes possible and desirable to enclose such varied and inharmonious features, but it is not always necessary æsthetically nor always practicable to so screen them.

Pages 42 and 43 of "Architect *vs.* Engineer" show ærial conduits utilized to bind the building groups together instead of crawling over and among them. On 44 and 45 the correct and incorrect ways of butting ærial gangways into buildings are shown. Preserving the window banding ties the elements together. Where possible, the maintenance of a single scale pane and window openings proportioned to the unit do much to maintain unity in the arrangement. When this unit can find repetition in doors and brick courses, a still more unified effect is assured.

Messrs. Schupp and Kremmer give advice in "Architect *vs.* Engineer" to the architect. Accepting the architect as one sensible to beauty and amenable to advice from the engineer, his value is established. Only when the age decides against pride in the monuments to its industry will the architect prove unnecessary. Only when the architect is not content with a real solution of his problem, but prefers to make a stage setting, will the engineer do better without him. The age has elements of greatness too vast to become the property of one profession, and solving collective problems requires collective thinking. Industry gives us something entirely our own to express without relation to what other ages have hitherto expressed, and herein lies inspiration.

EDITOR'S NOTE. *To Mr. Arthur T. North we are deeply indebted for permission to reproduce a number of the illustrations from the book on German industrial buildings by Messrs. Schupp & Kremmer, published in Berlin this year, entitled "Architekt und Ingenieur." This book was sent to Mr. North by his friend, Dr. Edmund Schueler, who, due to a serious illness this summer, was unable to prepare for us a review of this important work on the architecture of factory buildings, which was finally written by Shepard Vogelgesang of the office of Joseph Urban. This subject of carefully studied architecture in the design and arrangement of factory buildings is only in its infancy in this country. It is recommended that all architects and engineers interested in architectural improvement in the design of factory buildings should study carefully the work of the several foreign architects, as well as the foreign books suggested by Mr. Vogelgesang in his brief but interesting article.*

BOOK DEPARTMENT

THE DESIGNING AND PLANNING OF AIRPORTS

A REVIEW BY
CLIFFORD WAYNE SPENCER

TO be forward-looking is one of the most important characteristics of the successful architect as well as of those engaged in other professions. Architecture should be not only abreast of the times but several steps in advance, so that as soon as an important new industry develops, architects will be ready and competent to provide for the proper housing of that industry in buildings appropriate in design and convenient in layout. It is very evident that the next few years are to see a phenomenal development in the air transport industry all over the world. It is still an infant industry, and the ground has scarcely been broken. Indeed, it does not require a very vivid imagination to visualize in the near future the day when the bulk of all passenger travel will be through the air and when much of the freight will be transported by the same means. It will be a great advantage for people to live in pleasant temperate regions and be supplied with food brought fresh from luxuriant tropical sections in gigantic planes within the period of a very few hours. Such gigantic transportation systems as are certain to develop will require a great number of specialized structures and terminal facilities. As the architects of a few decades past have been concerned with the building of great rail and shipping terminals, so the architect of the future will be called upon to design great airports which will combine many features of railroad terminals with facilities necessary for travel by air. This time is not far distant.

The airports so far developed in America are surprisingly disappointing as to both appearance and convenience, consisting too often of a few dilapidated looking shacks grouped about a dusty, uneven field in the midst of a desolate waste of dumps and ash heaps. Such surroundings have a very definite effect on the popularity of travel by air, since the dispiriting impressions gained at the start and finish of an air trip will do much to counteract the genuine pleasure to be experienced from a trip by air. Certainly a person who has to undergo a combined sand and cinder blast or to tramp through mud and water and ride in cold weather with water-soaked feet will not be in a hurry to repeat the experience. Of course such conditions do not exist at all fields. Some of the newer fields, especially in Europe, are very pleasing and convenient, and the arrival and departure of planes take place with all the smoothness, quiet and order of a modern rail terminal. In many places the planes are warmed up at a considerable distance from the platform and brought quietly into position, and the passengers pass from the waiting rooms to the planes through covered passageways, after which the planes move smoothly away at a signal from a central control. As has been said, the air passenger service in Europe is much in advance of that in the United States, due in a large measure to encouragement from several European governments in the form of subsidies and other aid. This lead of European over American facilities is being cut down through the efforts of private citizens and increased interest on the part of the public.

Some of the newer fields in this country have followed foreign precedent and are models of efficiency and good design. There can be no doubt that such fields will increase rapidly in number, and many forward-looking architects are preparing to take advantage of the opportunities which are sure to arise in this field. In order to supply information to those who design and operate airports as well as to stimulate airmindedness in the general public, Lieutenant-Colonel Stedman S. Hanks, of the U. S. Air Corps Reserve, has made an extended tour of the important airports of Europe and has studied their advantages and shortcomings with relation to the construction of airports in the United States. The results of these investigations and of Colonel Hanks' extensive knowledge of the subject are published in a book entitled "International Airports." The design, construction and operation of the important airports of Europe are carefully studied and compared with some of the best in this country, and there is given considerable information on airport operation in foreign countries which has never before been available in printed form. Many of the most noted authorities and men high in European and domestic air circles have coöperated by supplying information resulting from their vast and varied experience. Among them are Major G. E. Woods-Humphrey, General Manager of the Imperial Airways; Colonel the Master of Sempill, President of the Royal Aëronautical Society; General Sir W. Sefton Brancker of the Air Ministry; A. Plesman, Director of the Royal Dutch Air Lines; M. H. Kahn of the Society for the Promotion of Aëronautics in France; Director Otto Merkel, Dr. Dierbach, and Captain Otto Bertram of Deutsche Luft Hansa; and many other heads of air groups and directors of airports.

The international nature of air travel in Europe introduces many considerations into the study of European airports which as yet have not had much influence in America. However, with lines being established to Canada, Mexico, the West Indies and Central and South America, these factors should be taken into consideration in planning American airports. An important advantage of providing an airport with pleasing, permanent looking architecture is that it conveys to the public mind the fact that air travel is an established thing and is here to stay, a feeling which is not fostered by the American factory shed type of building. As

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planes of great size are expected to be developed in the near future, the hangars should be made much higher and wider than at present seems necessary, and in the layout of a new field ample provision should be made for a great increase in the volume of air traffic. The mechanical and scientific equipment of the fields should include such apparatus as will supply weather information to the fliers, and a new development in Europe which will doubtless become universal is direct radio communication between the fields and planes in flight. By the use of this service it is possible for a pilot to learn his position by means of triangulation with two stations, even though he be lost in a fog. The safety advantage of this will be quite evident.

The direct results of Col. Hanks' study of European airports is given in the form of detailed descriptions of famous European fields such as Tempelhof at Berlin; Le Bourget, near Paris; Croydon at London; Schiphol at Amsterdam; Waalhaven at Rotterdam; Statens Lufthavn at Copenhagen; and Littorio at Rome. Representative American airports are those at Buffalo and the municipal airports at Chicago and at Oakland, Cal. Other ports are shown in plan and illustration and give a very clear impression of what the modern airport should be like. Conditions of European air travel are made clear in the chapter "Impressions of an Air Voyager in Europe."

The airports of Europe closely resemble railway stations, being busy all day long with planes arriving and departing on schedule. The average European airport covers about three quarters of a square mile and has hangar space ample for the largest planes with fuel storage for about 30,000 gallons of gasolene and oil. There is usually an attractive restaurant, and there is a staff to supply reports as to wind direction and weather conditions along an entire route. The handling of passengers and freight at an airport is assuming greater importance daily and requires a considerable staff of operators as well as much forethought in planning. The workings of an air transport system are rather complicated and should be carefully studied by those interested in airport design. It is probable that the bulk of air transport in the United States will soon be concentrated under the control of one or a very few large companies as is the case in Europe where the Deutsche Luft Hansa, Imperial Airways, and Royal Dutch Air Lines carry the bulk of the passengers and freight. In the case of the Deutsche Luft Hansa the airports are constructed by the cities under the guidance of an expert furnished by the Luft Hansa, thus insuring a large number of well planned fields throughout the country.

The desirable features to be included in a well planned airport as described by Col. Hanks include a few briefly summarized points. The airport should be at the junction of several feeder air routes and on a main trunk line with good transportation facilities and close to the business section of the city. If possible the city itself should be located to the leeward of the field so that prevailing winds will not blow smoke over the field. Present practice is to have fields of circular form with eight runways orientated with respect to prevailing winds and not less than 3,500 feet in length. A carefully designed drainage system should be worked out so that the field will not be wet and muddy. Runways where necessary should be smooth and free from dust and should be reached by a paved roadway to allow planes to "taxi" smoothly into

position for starting. The buildings should be located well away from the field to allow an adequate safety zone and a clear approach. They should be laid out so that traffic may circulate freely without collisions or causing congestion. The structures should be built in accordance with the best practice of modern fireproof construction, and the design be carefully studied for architectural character. The planning of lighting is a most important phase of airport design and is fully treated by Col. Hanks in a chapter on "The Lighting of Airports," as is also the subject of "Communication, Radio, Telephone and Telegraph." A summary of "Typical American Airport Rules and Regulations and Regulations of the United States Air Commerce" gives much useful information as to the actual manner in which planes should leave and enter an airport, all of which should be thoroughly understood by anyone undertaking design in connection with airport construction. A great deal of similar information is contained in the appendices dealing with the International Air Navigation Convention, the Pan American Convention on Commercial Aviation, Typical International Air Commerce Regulations, and the Berlin Airport Company's contract with the city of Berlin.

The complexity of factors entering into the design of airports calls for a highly specialized study of the subject and naturally involves a great deal of coöperation between the architectural and engineering professions in order that the fields may present a pleasing appearance and be scientifically and practically correct. Already men in architectural offices in New York and throughout the country are busy with the design of airports, and as the air transportation industry expands there are certain to be greatly enlarged opportunities in this field. It is hard, at this early stage, to determine just what the nature of the airport of the future will be, but the present tendency seems to be toward combining other features with the actual necessities for flying in order to increase public interest as well as to provide pleasant pastimes for passengers and those awaiting arrival of planes, as at the Littoria Airport in Italy, which is composed of a two-story hangar building, a three-story airplane factory with a three-story observation tower above, a hotel, club house, tea garden, athletic field, and a concrete grand stand. The effect of all this has been to greatly increase the interest of the Roman populace, and other cities may well profit by the example. It is to be hoped that the architectural profession will seize this opportunity.

INTERNATIONAL AIRPORTS. By Stedman S. Hanks. Lt.-Col. Air Corps Reserve. 195 pp., 5¾ x 8½ ins. Price $5. Ronald Press Company, 15 East 26th Street, New York.

RUSSIA, EUROPE AND AMERICA: AN ARCHITECTURAL CROSS SECTION. By Erich Mendelsohn. 224 pp., 9 x 13 ins. Price $6. Architectural Book Publishing Co., Inc., 108 West 46th Street, New York.

IN "Russia, Europe and America," Erich Mendelsohn pictures Europe in a sort of spiritual-economic sandwich. In type, in illustrated material, Europe's part in the work and in the world scheme becomes small. Russia's depth of feeling, intuition, and religious urge, and America's rationalism and unproblematic power of realization are seen as the dominant world forces of the day, —America individualistic and earthy, Russia collective and God-aspiring. This standpoint Mendelsohn presents

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with power in writing and with poetry in illustration. America's steady growth as an industrial organism is depicted parallel with Russia's yearning toward the transcendent human relationship, now changed from God to man, to man and organized society; a yearning born of the frustration of armies of Russians in the war now seeks fulfillment through the technical ability of America to equip society on a collective scale.

In Russia this phenomenon finds expression in the striving for a utilitarianism out of proportion to the means of attaining it. Contrasted are illustrations of the building of a skyscraper in Chicago and a power station in Kief. The building in Chicago springs like a plant from the ground, carrying its own structure and adding cell on cell to its organism; that in Kief resembles the laborious conjuring of a phantasy. For its scaffold, a Russian forest is moved like Shakespeare's wood to the site, and in its branches primitive man squanders material. America has also its thirst to transcend the everyday realization of a technical adroitness,—to express a greater America, wherewith America loses itself in ornament. Nearly all efforts at impressing ourselves in this way Mendelsohn meets coldly, with nothing like the feeling that a justly conceived aspiration is successfully reached. Contrasted with the Iberian gate in Moscow, the Church of the Transfiguration and Wassilij Blaschennyj, anything America has to show in the matter of decorative feeling must of necessity appear impoverished. That the Russians in their detail can also produce trash is exemplified by the Church of the Resurrection. The Russian rush to use of glass and steel, factory chimneys and reinforced concrete is condemned as an illogical substitution of media in expressing idealism. Some of the German feeling for material pushed to its logical final expression has been grasped by the Russians without adjustment to other architectural considerations,—the technique of making these dreams practical, the understanding of how to make them suitable to Russian climatic conditions and Russian economic life. America possesses technique and common sense. Russia, alas, monopolizes imagination and vision and daring. Of New York's "Gateway of the Nation" Mendelsohn says pithily: "It is not alone America's size and wealth which are pathetically symbolized in the Gate of the World."

As the filling in this sandwich, Europe's position is that of adjustment to a situation full of peril and fraught with problems. Europe is pictured as antagonistic to the changing newer world,—out-distanced in wealth and power by America at the start, too spiritually inelastic to make the Russian leap, and too divided for taking concerted action. Yet Europe was ever the *locus* of good sense and genius, of wisdom, and invention. Let Europe concentrate on itself, and in so doing it will concentrate on the constructive basis of the world edifice and the world law. Among the European buildings illustrated in this volume the author reserves the palm for several Dutch structures,—the airdrome at Orly; and with justifiable lack of reticence, his own textile factory at Leningrad. Some slips of logic on the part of Le Corbusier are noted without proffering the usual consolation of reference to him as a "poet." In "America, Europe and Russia," Mendelsohn has, himself, achieved poetry and also an exposition founded on an interest of which not one section but the whole world is the scope.

THE
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VOLUME LI SEPTEMBER 1929

CONTENTS

PART ONE—ARCHITECTURAL DESIGN

PART TWO—ARCHITECTURAL ENGINEERING AND BUSINESS

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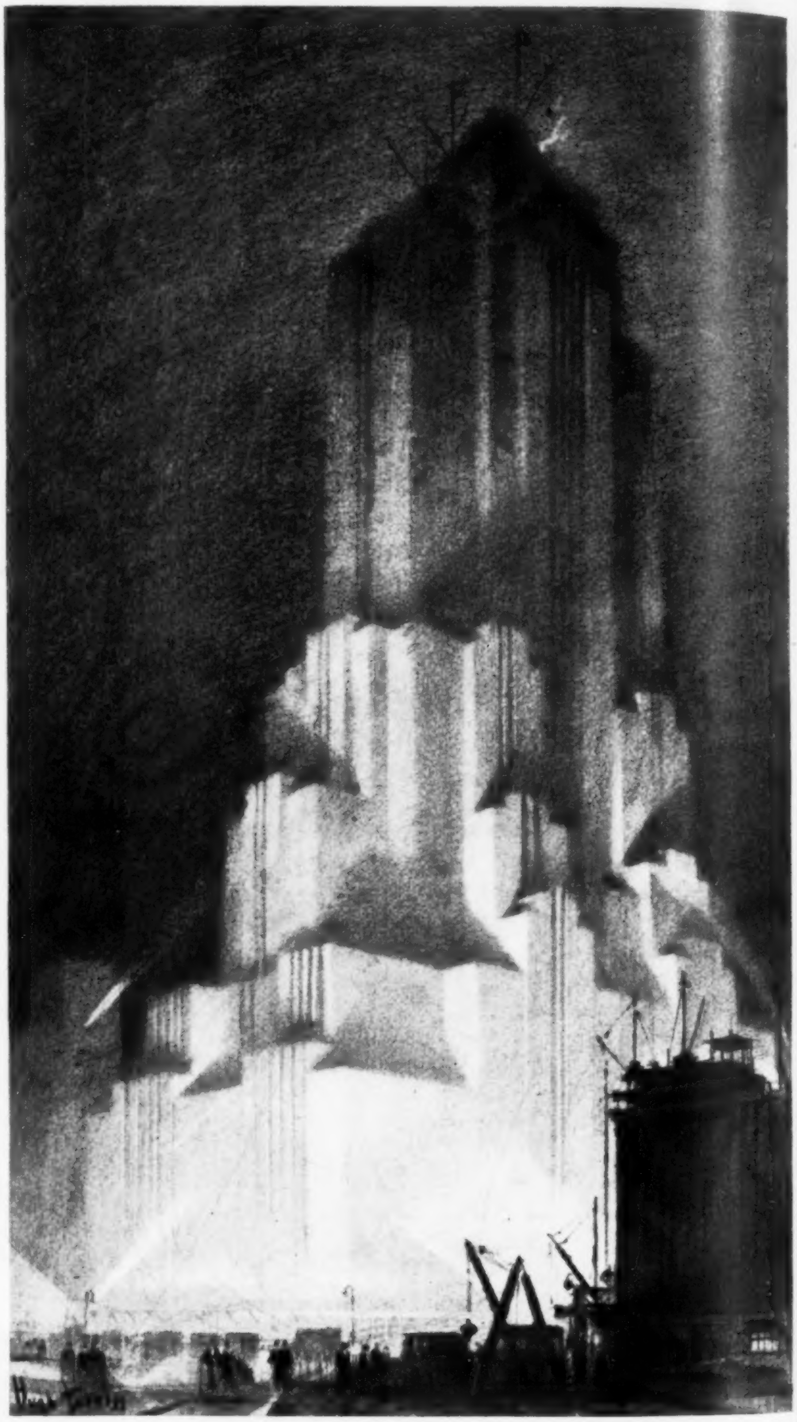

A reproduction of this rendering by Hugh Ferriss, suitable for framing, will be mailed free of cost to any architect

ACRES IN THE AIR

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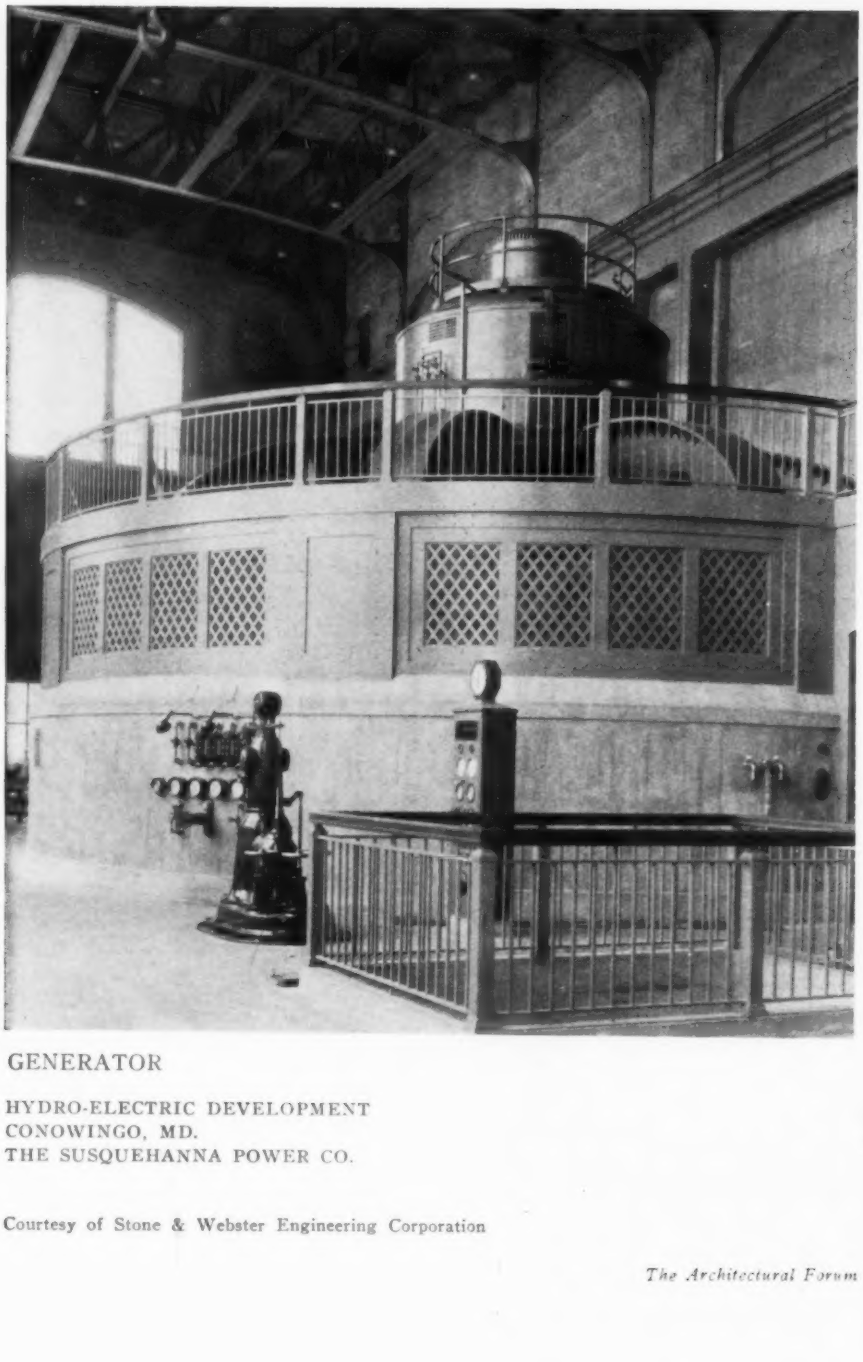

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THE
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VOLUME LI | NUMBER THREE

SEPTEMBER 1929

ROOF TYPES FOR INDUSTRIAL BUILDINGS

BY
CARL de MOLL
ARCHITECT AND ENGINEER, THE BALLINGER COMPANY

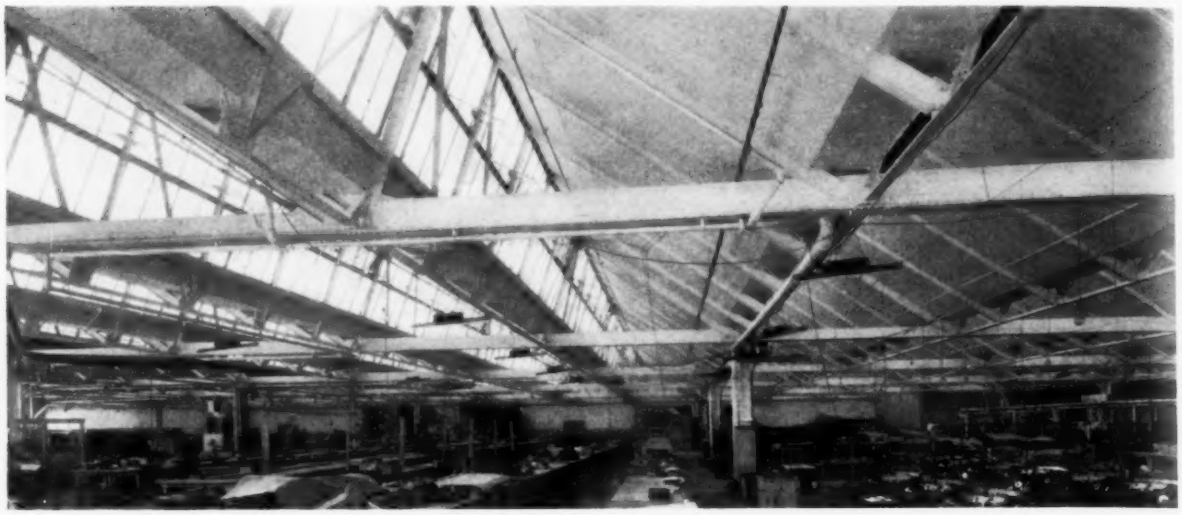
ONE of the modern archæologists, writing on the development of religious and domestic architecture, considers that the roofs of various buildings are designed in accordance with the ancestry of the people,—whether they are descended from a nomad tribe living in tents or from a clan of troglodytes inhabiting caves. From this he deduces the development of the domed roof in one civilization and that of the peaked roof, carried by posts or trusses, in others. While this is an interesting speculation historically, it has little bearing on modern design.

The roofs of modern buildings are divided, however, into two classes. Roofs of municipal, religious and domestic buildings are designed either for shelter and to keep out the weather, or æsthetically for architectural effect. The roofs for industrial buildings, however, while purely utilitarian, must be designed for a number of different functions. A roof is usually considered simply as a cover for protection from the elements, but as applied to an industrial building, there are many considerations, almost the only function in common being to keep out the rain. Roofs are designed to keep out the sun and also to admit the sun; to keep out the air and also to let out air and gases; and to keep out the light and also to admit the light.

The simplest form of roof is, of course, that over the narrow building, with wood joists spaced closely together, boarded on top, and with some covering of felt or metal similar to that of a small city house. As industrial buildings become larger and more complicated, and as modern production becomes more complex and requires larger units, it is necessary to reduce the number of columns to get wider spaces for modern machinery. This has led to the use of heavy girders and various forms of trusses, the simplest form being the "A" truss, high in the center and low at the eaves, giving a distinct pitch in two directions, with a monitor or two-sided skylight at the apex, where light is needed and sunlight is not objectionable, or a single saw-tooth along the north side so as to afford light without direct sunlight's entering the building. This, of course, is only possible where the trusses run north and south. The trusses of a Howe, Pratt, Warren or lattice type can be used, and these are made of either wood or steel, depending on the length of the span.

In a roof constructed of steel trusses, the columns should be fireproofed, and unless the roof is very high above the floor, all of the steel should have a fireproof covering of concrete or some similar material. This is not so necessary in a building equipped with automatic sprinklers, but it should be considered, especially where the spans are large and where the destruction of one truss would wreck a large area of roof. There have been a number of very interesting types of wood trusses developed, some of which are made of relatively thin material, spiked together without the use of heavy steel rods. These are usually of some form of the lattice truss, and can be made with flat or curved top chords and have even been designed for an extreme overhang for use in grandstands of race courses, where a line of posts along the front would be very much in the way. These are, of course, much cheaper than a steel truss of the same span.

In some modern manufacturing plants in this country, where the buildings are several hundred feet wide and over 1,000 feet long, the question of providing proper ventilation is very serious, due to the fact that in the summer most of our prevailing winds are from the west and south. This means that it is difficult to get ventilation through the plant without some artificial assistance. Also in the construction of buildings of



Super-span Sawtooth Roof of the Atwater Kent Manufacturing Company, Philadelphia
The Ballinger Company, Architects and Engineers

these enormous areas, it is necessary to obtain most of the light through the roof. This can be done, first, by the use of glass laid into the body of the roof; secondly, by using flat skylights following the approximate slope of the roof without ventilation; third, by using vertical or slightly sloping sash on the sides of monitors, projecting above the roof surface, these sash, pivoted or hinged, allowing the hot air to escape or fresh air to enter; and lastly, by constructing what is known as the "sawtooth" roof, which derives its name from the similarity between the cross-section of the roof and a saw. These are usually built with the glass facing the north, the glass being either perpendicular or built on a slight slope, and the rest of the roof being solid, sloping from the top of one sash to below the bottom of the next sash to the south. This form of roof affords the greatest amount of light with the least quantity of direct sun at the work level, and as the light is almost entirely from the northern part of the sky, it has a much steadier intensity than light from any other direction. This type of roof was developed in England many years ago for textile mills, and it is still the best for most forms of production requiring strong light.

For many years these sawtooth roofs have been designed with a great number of posts. As these were usually very much in the way, the next development was to raise the entire roof high enough to get a truss of the Howe type to carry a number of skylights across the building. This, of course, raised the side walls and also increased the cubic contents of the building, not only increasing costs, but also increasing the cost of heating. A much more economical method of framing sawtooth roofs without columns is what is known as the "super-span construction." This system was developed and patented by The Ballinger Company, of Philadelphia, and employs both longitudinal and transverse trusses. Back of the glass is an ordinary type of truss which supports the roof longitudinally for a distance of from 60 to 70 feet. These trusses, in turn, are supported at intervals of up to 70 feet by a heavier transverse truss whose bottom chord is at the same level as the valleys, and whose top chord extends outside the sawteeth, connecting their peaks one to another, the structural members of the skylights becoming the struts and braces. It is similar to an ordinary bridge truss, except that the angles of the web members are not equal in each pair. With this system of framing, spans of 100 feet in width and of any length are constructed at only a slightly greater cost for the building than for a sawtooth roof constructed on columns in each valley. If widths greater than 100 feet are to be roofed, a row of columns with a maximum spacing of 70 feet is required for each 100 feet. In the spacing of a large number of similar machines in a limited floor area, we find that the omission of columns is of great importance. In a building 100 feet wide, roofed with a clear span, it is frequently possible to put from 15 to 20 per cent more looms than in a building with three lines of columns.

Another type of roof construction is the arch, which may be of masonry, concrete, bow-string truss or a type of lattice truss. One of the best examples of roofs of this character was the steel arch roof formerly over the train shed in the Broad Street Station, Philadelphia, which

Sawtooth Roof of the John Warren Watson Company, Philadelphia
The Ballinger Company, Architects and Engineers

had a span of 300 feet and a rise of 108 feet. This was destroyed by fire, and as this type is very expensive to build, and very high in maintenance cost, it is, undoubtedly, obsolete.

There have been a number of roofs built of the curved truss similar to a Howe truss, in which the thrust is taken care of by tie-rods. In continental Europe a large number of factories are being built with concrete arch roofs of up to about 50-foot span. These are very interesting pieces of construction, due to the extremely economical use of material. A roof of 45-foot span is built with a 4-inch concrete slab with a rise of about 8 feet, and with a radius of about 32 feet. There are ribs of 6 x 8 inches spaced on 16-foot centers, with reinforced concrete tie-beam of about 6 x 8 inches at the spring lines under each of these ribs. These roofs look very well and are remarkably economical in continental Europe, due to the fact that building materials are relatively high in price and labor costs very low. The writer does not know of any case where these have been used in this country. There are, of course, many shapes and designs which have been used for roof construction, due to irregularities of plant or unusual conditions, but in industrial construction, it is more economical to use the simplest form possible, designing beams or trusses to use standard shapes.

The construction of the roof between supports may be concrete slab, either stone or slag concrete, or concrete made of cinders. These concrete slabs are erected with wood forms, or in some cases with a stiffened wire reinforcement, upon which the concrete is applied without supporting formwork. Another similar type is built of corrugated galvanized iron with concrete slabs, without reinforcement. Other types are cast gypsum, either cast as in the case of concrete, or made of slabs of gypsum cast in forms on the ground and set in place; wood plank or large slabs made of baked terra cotta tile, cement, concrete tile or a tile made of asbestos and cement. There are also roofs simply covered with corrugated galvanized iron or corrugated asbestos lumber. Most of these types of roofing, of course, have to be covered with some waterproofing material. Where the roof is steep, it can be covered with wood shingles, asphalt shingles, asbestos shingles, felt roofing combined with either tar or asphalt, with or without a crushed slag or stone surface, or in some cases with a prepared felt roofing which is applied in long sheets cemented together along the edges. Where the roof is flat, it is necessary that this felt roofing be an impervious membrane, as there is always danger of a certain amount of water's remaining on the roof during or after heavy rains. Where the roof is used as a promenade, or where there is much foot traffic over it, it is necessary to apply terra cotta tile or heavy slate on top of the membrane to take the wear.

In all roof coverings, the most important point seems to be the flashing, that is, where the roof connects with gutters or connects to the side walls, most of the leaks occurring at these points, and as this portion of the roof is usually the flattest, most of the walking over the roof, and therefore most of the damage to the roof, takes place at these points. The ideal flashing is one that is water-tight, flexible, and not affected by temperature changes, as the difference between temperature in the sun in summer and the extreme cold in our northern winters, will amount to nearly 170 degrees, sometimes more.

Sawtooth Roof of the Building for Leland Electric Company, Dayton
The Ballinger Company, Architects and Engineers

One of the most important questions in the design of a roof is the condition of temperature and humidity which is to be maintained inside of the building. We are tending more and more to carrying certain ideal atmospheric conditions inside of our manufacturing plants, without regard to conditions outside. For many years it has been necessary to humidify most textile plants, not only to keep the fibers in proper working conditions, but also to avoid formation of static electricity. We find today that more and more plant owners are desiring a very accurate control of humidity, that is, within one or two degrees. This means not only humidification in the winter, but de-humidification in the summer, and with this high humidity, great care must be taken not only with the insulation of the roof, but frequently with many of the structural members. The water from the atmosphere will condense on the various parts of the roof and drip to the floor, and on the machinery or material in process of manufacture. We are, therefore, using fixed glass in our sawtooth skylights, putting adequate condensation gutters under this glass, and insulating the roofs with cork or other insulating material. Even in buildings where excess humidity is not a factor, we find in the far north that the insulation of a roof is frequently economically justified, due to the large reduction in the cost of heating the top story. In certain plants, where there are corrosive fumes, it is necessary to use non-corrosive metals in the flashings and the sash bars. These are made of Monel metal in some cases, and in other cases, of lead.

The most important thing in the construction of roofs of large areas is the recognition of the relatively large amount of expansion and contraction of the entire roof, due to temperature changes. This imposes serious strains on roof flashings, and on metal sills of continuous skylights. Failure to compensate for these stresses is the cause of the majority of roof leaks in buildings of this character. As our modern civilization is so intense and all work is done at such high pressure, it is important that every building should be designed for the most efficient use. Only in this way can the fatal date of obsolescence be moved far ahead in the future. We know that by careful design, a building is available for use a great many more years than formerly. It is, therefore, imperative in the designing of a modern production plant, that the best engineering service be obtained, as only by the employment of experienced experts in architecture and engineering is it possible to obtain the best and most efficient building for the least expenditure of the manufacturer's money.

FLOORS AND FLOORING FOR INDUSTRIAL BUILDINGS

BY

WALTER M. CORY

CONSULTING ENGINEER

THE selection of proper floor wearing surfaces is of prime importance in the design of modern industrial buildings. The floors are subjected to a large variety of severe services, and failure of the floor surface to stand up under operating conditions may cause damage to merchandise or structure resulting, directly or indirectly, in appreciable financial loss.

The careful designer will make a thorough study of general and special requirements in each division and sub-division of a plant and then select a suitable wearing surface for each. In studying the subject of floor wearing surfaces, it is necessary to inquire very thoroughly into the work to be performed thereon. Often a rather obscure condition, such as water or oil drippage from manufacturing processes, will eliminate use of a surface which would otherwise be ideal. Often requirements are so exacting or conflicting that no known floor surface properly meets the condition, and the designer is forced into unsatisfactory experimentation, or else he must openly use that which most nearly conforms to requirements.

Economic considerations naturally play an important part in the selection of floor surfaces. One must not only take into consideration the initial cost of the floor in place, but must also include the cost of any special finishing treatments, increased structural costs due to the possible added dead load, and maintenance costs, and at the same time obtain a satisfactory equivalent rental cost for the entire structure. Another important consideration which must not be ignored is the reluctance of financial and loaning interests to view single or special use buildings with the favor accorded general or multi-use structures, for obvious reasons.

The floor designer should generally use recognized standards except where occupancy demands special treatment, and in selecting these surfaces he should choose that most adapted to other uses and requiring the least amount of special construction for its proper installation.

The present-day industrial plant usually covers a very wide range of operations in which a dozen or more types of floor treatment are required to properly meet the needs of a single building. No one flooring material is adapted to all the different manufacturing processes.

A typical industrial plant manufacturing a commodity combining textile, metal and wood working departments may call for use of all these kinds of floor surfaces throughout the building:

Tile Used in an Entrance Lobby

Embossed Linoleum in Office Space

Battleship Linoleum Floor in the General Offices

Entrance lobby .... *marble.*
Passenger elevator floor........ *rubber tile.*
General office.................. *linoleum.*
Private offices.................... *carpet.*
Drafting room................ *hardwood.*
Receiving and shipping dept... *metallic hardened concrete floor.*
Sewing machine rooms...... *factory maple.*
Machine shop and press room.. *wood block*
Plating room.................... *mastic.*
Foundry .... *earth.*
Toilet rooms.................. *glazed tile.*
Stairs and passageways.. *concrete, with non-slip abrasive metal.*

It does not follow that a proper selection of floor surfaces for one building will apply to another structure, even if used for manufacturing similar commodities. Different processes, methods of handling, class of personnel, location and financial considerations would probably result in quite a different selection of floor surfaces.

The designer should acquaint himself with the early history of the subject, as this will be of great value in getting a proper perspective. A brief historical sketch of the subject during the last quarter century may be of general interest, as the evolution of this phase of industrial building design has been influenced by the general trend toward economical, effective, fireproof and sanitary factory construction.

The industrial building in common usage about the beginning of the twentieth century was the so-called "mill type" structure. This type consisted of brick bearing walls with timber columns, girders and hardwood flooring over wood joists. Good prime hardwood was then economical and readily obtainable, and it made excellent floor wearing surfaces, particularly for the textile industry.

Several serious fires focused attention on one of the shortcomings of the mill type building and finally resulted in a modification of the design and produced the "slow-burning type mill" building. This type of construction retained the brick bearing walls and timber columns and girders, but called for all timber to be planed and free from sharp corners, and substituted timber beams spaced from 4 to 6 feet apart with planed, splined, plank underfloor and a hardwood wearing floor.

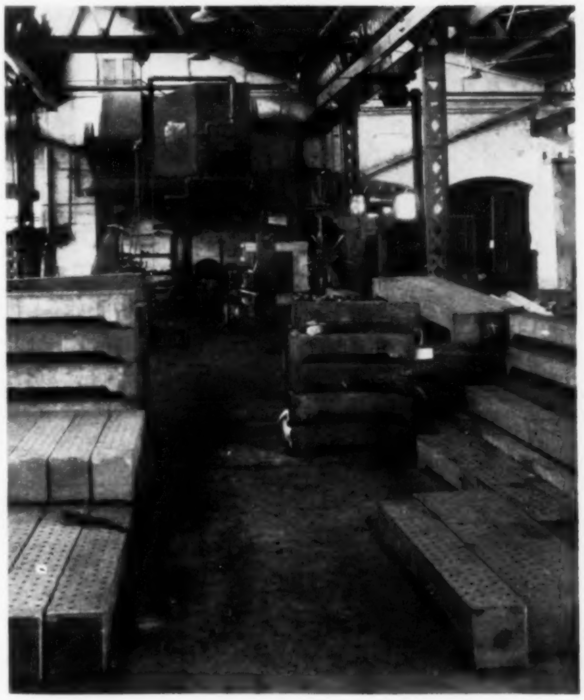
Iron and steel soon entered into the construction of these buildings, first by the substitution of Lally columns for the wood columns, and later structural steel was substituted for the columns, girders and beams. The use of structural steel in building construction work made it possible to construct higher buildings without too much loss of floor space due to columns, and the use of the bearing wall type of building gradually gave way to that of the skeleton type of construction, which, as its name implies, depends

Rubber Tile in the Cafeteria of Textile Machine Works

on a skeleton for its strength, and the materials composing its enclosing walls, floors, etc., are primarily determined by other than structural considerations.

The transition to structural steel developed the need of fireproofing the structural members. In the slow-burning mill type buildings, the plank underfloor had served to carry the floor load to the beams. It was necessary to use fireproof construction to carry the floor loads to the beams and floor arches. These were first of masonry, and later concrete arches were developed to meet this requirement. At first the hardwood floor wearing surface was retained on top of the fireproof arch, but progress in the use of concrete gradually made this material a contender for the floor surface as well as for the supporting arch.

Concrete was used in industrial building work to a limited extent early in the century, but many years elapsed before reinforced concrete began to make serious inroads on the older types of construction. With the improved design of exteriors of this type of building, introducing architectural effects in the concrete itself, as well as using brick veneer, reinforced concrete soon practically dominated the multi-story industrial building field, and concrete has become a strong competitor for supremacy as a floor wearing surface. This material has many of the basic requirements of the ideal floor for general purposes



Metallic Hardcured Concrete Floor for Heavy Duty

Machine Shop Floor of End Grain Wood

and receives full recognition in present-day floor design. It is economical in first cost; the wearing surface may be considered part of the structural design; it can be made hard, practically impervious, sanitary, fireproof and inert, and is almost universally obtainable. Concrete has its limitations as a floor surface, however, and will not satisfactorily serve for numerous special uses. Oil and acid have injurious effects on concrete; water on floors, if in quantity, will penetrate the minutest cracks in suspended floors; application of intense heat will cause concrete to disintegrate; alternate applications of heat and water are likely to produce spalling. Hardening of concrete is influenced to some extent by the weather and the method of finishing as well as by the mechanics or workmen doing the actual finishing. It is, therefore, more or less non-uniform. Hardness, too, militates against its use in many cases, and the more decorative and artistic floor surfaces supplant it in others.

The floor surfacing industry has been experiencing steadily increased demand to meet both economic and special requirements, and we can look for considerable activity in this field. The enormous increase in the use of metal in almost every commodity has resulted not only in a demand for floors capable of withstanding the heavy duty entailed but also many complementary services in such places as plating rooms, rust-proofing rooms, etc. The early foundries were in one-story buildings with earth floors, but it is

Applying a Coating to a Concrete Floor to Make it Hard and Dustless

not uncommon now to find these activities on upper floors of multi-story buildings, and the floor wearing surface must meet the requirements.

No attempt has been made in this article to recommend any particular type of floor, as each may be used to advantage by the skillful designer, and the confines of such an article are much too small to treat even one material exhaustively. In my practice, I check each material against the two requirements always present,—first, the service required, and, second, the cost of such surface treatment.

In general, concrete should receive first consideration in the floor wearing surface for any given service. It is usually possible to add a hardener, a waterproofing ingredient, or a coating to meet the majority of the general requirements. Concrete fails to meet many of the special requirements, and this fact opens the door to use of a large variety of special floor surfaces.

Depletion of the forests has made prime hardwood too expensive for industrial floor surfacing, except where its qualities are specifically required. This material makes a clean, resilient, warm and serviceable floor and is widely used, as flat grained maple for textile rooms and recreation spaces, and as end grained blocks for machine shops and similar usage. Oak also may be used to advantage under certain conditions.

Marble, travertine, vitrified tile, brick, slate and stone represent a class of wearing surfaces which are being used in increasing quantities in industrial building lobbies, entrances, etc., along with the growing demand for the display of a reasonable amount of individuality and æsthetic expression in the modern industrial building rather than viewing the structure as a mere enclosure to house an industry. General composition, individual taste, and financial consideration will usually dictate the choice of the materials.

Linoleum, rubber tile, carpets and composition floors are of a group which have numerous special uses in the industrial building and are particularly adapted to office use.

Mastic floors have proved exceptionally effective where acids or large quantities of water are encountered, and considerable success has been had in using this material for heavy trucking such as is common in printing plants.

The earth floor probably is without equal for the foundry floor, and it is used wherever possible for this occupancy. We have been discussing the adaptability of various materials for floor wearing surfaces in industrial buildings under the assumption that proper preparation, application, workmanship, protection and care in service are provided in each case.

If proper bond is not obtained between the sub-floor and the finished floor, the floor surface is likely to break down due to causes which would not affect the floor if a good bond were secured.

Proper workmanship is just as important as the correct design or use of proper materials. One must remember, too, that even after satisfying these three conditions, failure may result, for well bonded, well laid floors can easily be ruined by careless or insufficient protection immediately after laying and before the process has been completed.

If a floor is to give good and lasting service, it must not only be well designed, of proper materials and of good workmanship, but it must be known that the bond between the floor and the floor surface is complete, that the material has been protected from water, heat, cold, being used, etc., or if it be of a type which requires special finish after being laid, that the special treatment has been expertly given, and, last but by no means least, it must be serviced or maintained by the application of the several treatments which may be required depending on the material used, such as waxing, oiling, the use of water for cleaning or its non-use, etc. These special treatments as to the care of the floor should be insisted upon by the designer to the extent that he should see that full and complete instructions are placed in the hands of the owner and their importance forcibly brought to his attention.

It is only by adhering to all these principles under the present development of floor service treatments that the designer can hope for success.

ESTIMATING THE COST OF INDUSTRIAL BUILDINGS

BY

H. H. FOX

VICE PRESIDENT, TURNER CONSTRUCTION COMPANY

THE three usual kinds of estimates of the costs of industrial buildings are: (1) the cubic foot estimate; (2) the square foot estimate, and (3) the quantity survey. It is assumed that for the readers of THE ARCHITECTURAL FORUM no definition of these terms is necessary. The cubic foot basis and the square foot basis are similar in accuracy and reliability,—it might be more correct to say, in inaccuracy and unreliability. Neither is of any value unless used by a person of judgment and experience. Both experience and good judgment are needed.

A fourth method involves a compromise between the cubic foot estimate and the quantity survey. It might be called the "broken down" cubic foot method. It is based on a tabulation of the cubic foot cost of every trade in a number of actual buildings. Heating, for instance, in a series of industrial buildings, may vary in cost from 1¼ cents to 2½ cents per cubic foot; plumbing from .8 cent to 2 cents. When a sufficient number of analyses of this kind are available, it will be possible by considering the requirements in each trade separately to build up a total cubic foot cost for a completed building which will be more reliable than the cubic foot cost as usually determined.

This table shows cubic foot analyses of four industrial buildings:

Building No.	(1)	(2)	(3)	(4)
Structural Trades:				
Excavation;	$0.012	$0.007	$0.020	$0.007
Piles;	...	...	...	.014
Reinf. concrete;	.079	.077	.100	.075
Miscel. iron;	.004	.004	.005	.003
Masonry;	.005	.004	.008	.007
Windows (including glazing);	.004	.006	.006	.010
Roofing and S. M.;	.003	.003	.002	.004
	$0.107	$0.101	$0.141	$0.120
Finishing Trades:				
Cement floor;	$0.009	$0.006	$0.005	$0.007
Ext. cement finish;	...	.001	.002	.004
Doors, millwork and hardware;	.007	.007	.008	.014
Plaster and M. L.;	...	.001	.001	.002
Painting;	...	.004	.008	.006
Metal toilet parti.;	...	...	.001	.002
Special items.	.001	.002	...	.006
	$0.017	$0.021	$0.025	$0.041
Mechanical Trades:				
Plumbing;	$0.007	$0.009	$0.010	$0.012
Heating;	...	.012	.015	.023
Wiring;	...	.009	.006	.006
Sprinklers;	...	.007	.010	.009
Elevators;	...	.008	.013	.003
Ash hoists;	...	.001	...	...
Stack;	...	.001	.001	...
Tank and supports.	...	.001	.002	.001
	$0.007	$0.048	$0.057	$0.054
General Conditions	0.020	0.026	0.050	0.037
Total (without fee)	$0.151	$0.196	$0.273	$0.252

In determining the proper cubic foot cost to be applied in a given case, these items should be carefully considered:

1. *Foundation Conditions.* When tall buildings are placed on soil, especially on city plots where the footings cannot project beyond the building lines, the footing designs become complicated and expensive. New York is fortunate in having rock foundations for so many of its tall buildings. Piles of ordinary length, supporting a building designed to carry average industrial live loads, will add from 2 to 4 cents to the cubic foot cost of the building.

Foundations along a water front or on an old shore line beyond which new land has been made, may be very expensive both because of the depth to which it is necessary to go in order to find solid bottom, and because of old cribs or scows which may be encountered far below the surface and which will interfere with pile driving. The writer knows of one such case where the foundations of a building cost as much as the land on which the plant was built.

2. *Floor Loads and Column Spacing.* The cost of a building is increased by increasing the live loads or by widening the column spacing. If we take as a base the cost of a reinforced concrete building designed for live loads of 150 pounds per square foot and having 20 x 20-foot column spacing, the increase in cost per square foot caused by heavier loads or wider column spacing is approximately as shown in this table, assuming good foundation conditions, a height of six or eight stories, and that no structural steel column cores are to be included:

BUILDING NO. 1

Five-story and basement grocery warehouse, 273 by 105. Floors reinforced concrete; flat slab construction; 200-pound live load. Bays 21 feet square. 4-ton soil bearing. Concrete exterior. Total floor area, 166,500 square feet. Area of floors and walls, 229,000 square feet. Volume, 2,072,000 cubic feet

Live Load	Column Spacing 20' x 20'	Column Spacing 25' x 25'
150 pounds	0	$0.15
200 "	$0.08	0.25
250 "	0.18	0.37
300 "	0.28	0.48

3. ***Story Heights.*** The square foot cost of a building equals the cubic foot cost multiplied by the average story height. A building costing 25 cents per cubic foot and having 12-foot story heights will cost $3 per square foot. If the story height is increased, the cubic foot cost will decrease because the cost of the floor construction will be divided by a greater height between floors; but the cost per square foot will increase, because there are more wall area, more heating, etc., per square foot of floor.

4. ***Size and Shape of Building.*** The cost of the structural frame of an industrial building,—that is, of the footings, columns, floors and roof,—is about the same per square foot of floor area as is the cost of the walls and windows per square foot of wall and window area. Let us assume a unit of $1.50 per square foot for each, and take two buildings with 12-foot story heights, (A) 50 x 100 feet and (B) 200 x 200 feet. The cost of the frame, walls and windows for one story will be:

	Floor	Walls	Total	Per sq. ft. of floor area
(A)	$7,500	$5,400	$12,900	$2.58
(B)	60,000	14,400	74,400	1.86

This comparison shows clearly why a small building costs more per cubic foot than a large structure. There are other factors which increase the discrepancy, such as job overhead, plant installation, and more expensive heating plant on account of relatively greater radiation.

Quantity surveys are not usually made by architects. When a project is ready for final estimate as a basis for awarding a contract, that work is usually performed by contractors; and there is not much to be said about the actual steps taken in the preparation of a quantity survey which would be of interest to the readers of this article. The New York Building Congress published on February 10, 1925 a paper prepared by a committee of contractors describing the basis of a sound quantity survey and pointing out the pitfalls and errors which most commonly occur; but there seems to be one contractor born every minute who is willing to take work at a loss, and this paper has had no effect on the birth rate.

Estimating in General. There are some points related to estimating which, although they do not come strictly under the title "How to Esti-

BUILDING NO. 2

Five-story and basement printing building, 283 by 140. Reinforced concrete; flat slab construction. 19 by 20 bays. Concrete exterior. Typical live load, 250 pounds. 6-ton soil bearing. Total floor area, 234,850 square feet; area of floors and walls, 330,000 square feet. Volume, 3,010,000 cubic feet

mate the Cost of Industrial Buildings", may well be given heed to by architects in the interest of sound and accurate estimating. First, a specification should not contain the words "or equal." Few articles of different manufacture are "equal"; and only the architect knows whether he will accept an "equivalent" as an "equal." If an architect wants material of a specific manufacturer, he should first satisfy himself by direct negotiation with the manufacturer that a satisfactory price will be quoted to contractors who are to prepare estimates, and then specify the article outright by name. Or, he can name two or more acceptable manufacturers. If he does not choose to do this, he should describe the article and omit any manufacturer's name. Contractors have to gamble enough without having to guess whether an architect considers a Ford "equal" to a Chevrolet, or vice versa.

Secondly, there is the clause which occurs in many "General Conditions" which is grossly unfair and should never appear in a specification: "All Federal, State and Municipal Laws and ordinances and all rules and regulations and requirements of Municipal Departments or other public authority shall be considered and are hereby made a part of the contract. Any labor and materials in addition to that described herein or shown on the drawings necessary to comply with such laws, rules, ordinances or regulations shall be performed and furnished by the contractor." A contractor's responsibility for compliance with laws should be limited to his methods of handling the work.

Do not ask to have bids submitted on Monday mornings. For many hours before a bid is submitted, an estimator has to talk almost continuously to subcontractors in order to reconcile their bids with the plans and specifications. Most subcontract bids arrive in the mail the day before the date of opening the general contract bids. If that day is Saturday, there is a good chance that the subcontractor cannot be reached, and too much remains to be done on Monday.

All work of one trade should be specified under one heading. That sounds elementary; but there still exist specification writers who specify painting under the various headings of doors, windows, ironwork, plastering, or anything else that needs paint. One may stumble across odds and ends of ironwork almost anywhere. This adds to the difficulty of reconciling the subcontract bids with the plans and specifications.

It may seem that a disproportionate amount of space has been devoted in this article to the "cubic foot" and "square foot" methods of esti-

BUILDING NO. 3 (left)

Ten-story and basement loft building, 103 by 100. Reinforced concrete. flat slab construction. 200-pound live load. 3- and 4-ton soil bearing. Concrete exterior. Total floor area, 110,000 square feet; area of floors and walls, 163,500 square feet. Volume, 1,220,000 cubic feet

BUILDING NO. 4 (below)

Four-story shoe factory; F-shaped; 220 by 50, with wing 202 by 50. Reinforced concrete; flat slab construction. Bays 16 feet, 3 inches square. Concrete exterior, with brick curtain walls. Typical live load, 150 pounds. Pile foundations. Total floor area, 87,500 square feet; area of floors and walls, 154,300 square feet. Volume, 1,097,-300 cubic feet

mating as compared with the "quantity survey" method; but as a matter of fact, more remains to be learned about the former, and at times they are vitally important. It is often necessary to make a commitment for a building operation before data are available from which a quantity survey can be made; and when the financial soundness of such an operation depends on a slight margin, much depends, as can readily be seen, on the accuracy of the preliminary estimate.

FACILITIES FOR PERSONNEL WORK

BY
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INDUSTRIAL CONSULTANT

THE plant manager usually remarks to the architect "I want a thoroughly up-to-date layout for our personnel work, but the space and equipment must be kept at a minimum." For time and space saving, there are certain fundamentals of good design, equipment and operation in personnel departments, just as there are basic principles in designing a fireplace or a foundry, a kitchen or a concert hall. Ask any plant manager if he would like to save $1,500 a year in his overhead! Yet this expense can easily be incurred by a poor Employment Department layout that requires an extra watchman to guard its entrances and exits and keep applicants from getting into the plant.

This article will review the design and working principles of Employment and Medical Departments, without in any way setting up a standard of perfection. The discussion will be confined to these two sections only, and will not include Training Departments, Recreation Rooms, Wash and Locker Rooms, or other personnel facilities found in many companies. Attention will be centered on the small and medium-sized plant, where economy is essential.

Good personnel layout and equipment make a direct and continuous contribution to effective plant operation and to the reduction of overhead expense. The question is often asked "How much must be spent to obtain good personnel facilities, how much space is required, and what is the best location?" Good layouts and operating methods can be produced with much less money and space than is commonly supposed, provided the needs of each company are carefully analyzed to begin with.

Employment Department. The best location for the Employment Department depends upon the services it renders to applicants and to employees. If it is frequently used by the employees, it should be located where they can reach it quickly and conveniently, and if possible nearest the departments that use it the most. It is commonly assumed, in a company occupying several floors in a building, that the Employment Department must be on the street floor. This is not necessarily the best location, as it might be better to have the department on the second or third floor near the employees it serves, and have the applicants use the stairs or elevator. The fact is sometimes overlooked that when an employee goes to the Employment Department he usually is costing the company money and production, whereas an applicant for employment can spend additional time going to the department without any cost to the company or undue inconvenience to himself. Regardless of where the Employment Department is located it must have convenient access to the street or yard, and have its facilities so arranged that casual inquirers cannot get into the plant while on their way to it or after entering it. This should be arranged without the use of extra watchmen or other persons.

Almost all Employment Departments have frequent contact with the Cashier's Office or Payroll Department, and in some cases the employment manager supervises the shop timekeepers. In some companies the Employment Department pays off employees at termination, and in other companies the employee himself goes to the office to get his final pay. All these different policies must be considered in locating and arranging the Employment Department.

Diagram 1 illustrates an Employment Department combined with a Medical Department, located on the second floor of a four-story factory having 1,000 employees. The one main doorway must serve both departments as entrance and exit for applicants and employees, for factory departments and the street. There is natural light from only one side. The Employment Department has three rooms totalling 494 sq. ft., and the Medical Department, four rooms with 646 sq. ft., a total for the two departments of 1,140 sq. ft. A clerk seated in the Employment Waiting Room, near the large open doorway, can control the entrances to the factory departments and the exit to the street, and in addition can handle inquiries.

In practically every company the steps in hiring are fundamentally the same. Whether or not a separate room or space is required for each step depends on the frequency and intensity of use. For a large company, having many applications and engagements, there would be (a) Waiting Rooms, (b) Application Room, (c) one or more Preliminary Interview Rooms, (d) one or more Test Rooms, (e) a Hiring or Final Interview Room, (f) a Record Room and (g) the Personnel Manager's Office. "But," you say, "that is much too much. I am planning for a smaller company that can afford only limited space." You can probably reduce all the above rooms to two or three and still have a layout sufficient for your small needs. "How am I to

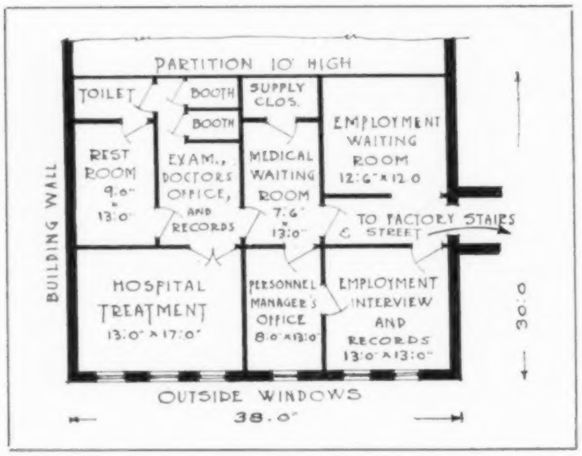


Diagram 1. Combined Employment and Medical Departments for a Factory

know how many rooms I should have, for a good up-to-date layout?" Here are some of the fundamentals from the experience of other companies that may help in deciding the plan.

Waiting Room. This is one of the two or three rooms regarded as an absolute requirement. It should be large enough to accommodate the average number of applicants at one time, with definite provision, however, through some expedient, for accommodating the peak loads that occur in every company. Early one stormy looking morning I visited a plant whose employment manager had advertised for a large number of skilled mechanics. The small waiting room, opening directly on the street, was soon filled and a long line of men formed along the sidewalk. A sudden downpour of rain drenched them to the skin. The higher grade, independent mechanics promptly sacrificed their places in line, more concerned with their comfort than immediate prospect of a job. Only the mediocre and unskilled were left for the employment manager. The money spent for advertising was practically wasted and the expected production from the new men was lost. Worst of all, the rain-soaked men carried a bad impression of the plant in their mind. This is one of the hidden losses that does not show up on the company books. It can be avoided by careful planning. It is not necessary to carry the burden of a large waiting room that is normally only half used; a small room can be used if it opens on a hallway or a stairway, or is adjacent to another room that can be temporarily supervised, or connects with a covered passageway in the yard.

The path of the inquirer from the street, to the waiting room, to the inquiry clerk, and back to the street, should be made as short and direct as possible, with no way of getting into the plant without permission. It is particularly important that the applicant who has been interviewed and either hired or rejected, does not pass out through the same room in which applicants are waiting interviews; see Diagrams 1 and 3. This may seem a minor point but it is important in planning. Let me illustrate its importance. A company had advertised for five milling machine operators. Among the first to apply was a man whose appearance and manner indicated that he was obviously below the standard required by the company. The interview clerk in rejecting him said, "Sorry, but there is no opening for you." In leaving he had to pass through the room where the remaining applicants were waiting, and naturally not having understood the distinction made by the clerk said, "Nothing doing boys, the milling machine jobs are all filled." All the milling machine applicants immediately followed him out, and the employment manager lost some good material.

Some companies require two waiting rooms, one each for male and female; other companies, with less intensive use, permit the two sexes to mingle in one room or set separate hours of interview for each sex. This latter method is practical only under very favorable labor conditions, and where the separate hours are advertised and known to applicants. Much the same remarks apply to one or two rooms for shop applicants and office and sales applicants. The decision depends upon the intensity of use and the policy of the company. A separate waiting room or entrance for employees is preferable so that employees and applicants for employment do not have a chance to engage in conversation. In most smaller type companies, however, one waiting room is made to serve for all applicants and employees, regardless of sex or type of position. Diagram 3 illustrates how even this one so-called indispensable room was omitted. One end of the lobby of the cafeteria and recreation hall was used during interview hours as a waiting room and of course never conflicted with

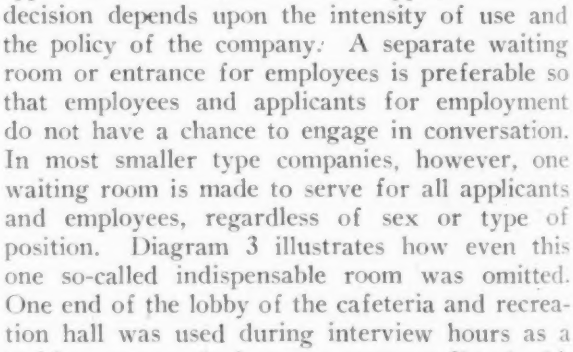


Diagram 2. Medical Department on the Second Floor of an Industrial Plant. Lighted by Skylights

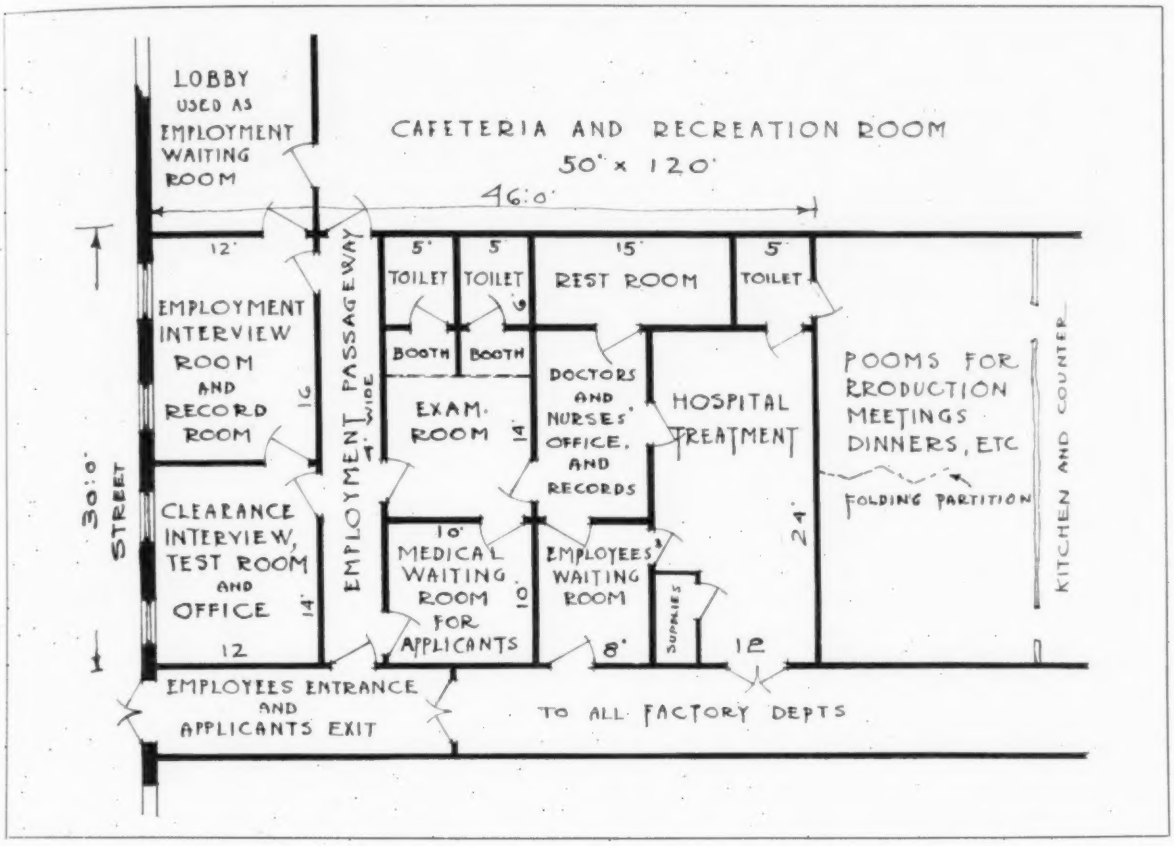


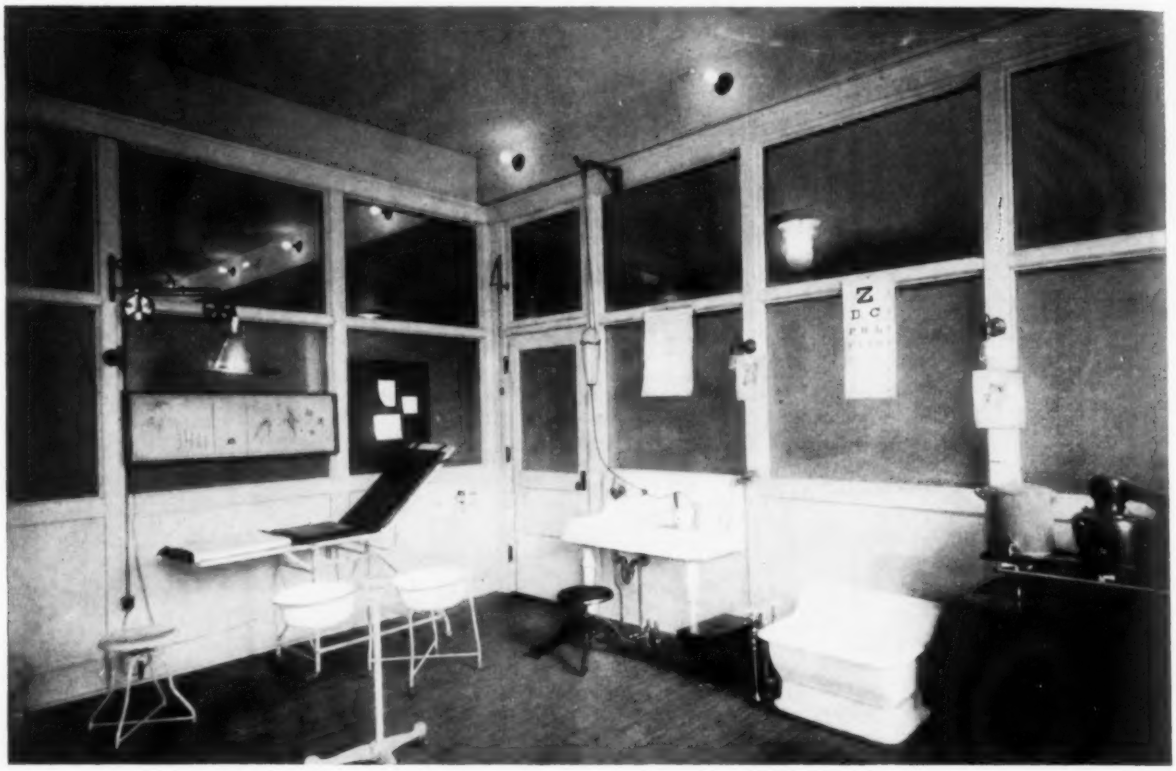
Diagram 3. A Well Arranged Layout for the Employment and Medical Departments of an Industrial Plant
The Ballinger Company, Architects and Engineers

its use as an entrance for other activities due to the difference in the time of its various usages. Approximately 150 square feet of floor space were saved by this method. The layout shows an Employment Department designed for 1,500 to 2,000 employees, of two rooms and passageway, totalling 480 square feet, on the street floor, with exits possible on all sides and having overhead light in addition to windows.

Application Room. "Never heard of one," say some managers. "Must have one," say others. The difference lies largely in company policy and labor conditions. Some companies give practically every inquirer a blank to fill out on the spot even though there is no job open, and use these applications as a prospect file from which to obtain employees when needed. If there are many applicants simultaneously filling out blanks, adequate table or shelf space is of course required. Other managers refuse to give out application blanks, and take a written record only when the applicant is being hired, in which case no separate application space is needed. Between these two extremes, the majority of companies doubtless take their place by giving out application blanks only to likely-appearing candidates for the hard-to-fill jobs. For this limited use, a small part of the waiting room or of the interview room can be fitted with a table or shelf.

Interview and Test Rooms. Here again the question "Are they necessary?" must be answered according to the actual needs of the individual company. Some companies have several small rooms or booths so that three or more persons can be interviewed simultaneously, each booth being shielded as to sight and conversation. The same booths can sometimes be used where hiring tests are given,—for office workers on typewriters, adding machines, etc., and for shop workers by means of manual tests. Whether the interviewing and the testing are done in one room or several, convenient access must be provided to the shop, office and medical sections. This allows for the practice in many companies of sending the applicant to the shop or office for interview by the department head for whom he is to work, and to the Medical Department for physical examination, all of which is usually done before the applicant returns to the Employment Department for formal hiring.

Hiring Room and Record Room. The hiring room, sometimes called the final interview room, can be used, like the old-time barroom, for many purposes. In it there may be combined the func-



Interior of a Well Equipped Room in a Medical Department

tions of taking applications, interviewing, testing, hiring and filing of records. It can be so used with entire satisfaction in companies that do not have frequent applications or engagements. Diagram 1 illustrates this type of use.

Manager's Office. One of the chief functions and contributions of the employment manager is the final clearance interview of employees at termination. Some companies insist that employees, regardless of position, rate of pay or reason of termination, be interviewed by the employment manager himself before an employee can be cleared from the payroll. This office should combine accessibility, privacy and control. It must be so located with connections to the shop and office that employees can readily reach the employment manager when required and that he can as quickly reach them; it must be enclosed or set off to permit confidential conversation in person and over the telephone, and, if possible, it should be placed so that the employment manager has visual supervision over the activities in the surrounding rooms under his control.

General Arrangement. Engineers and architects are frequently called in to analyze and improve methods of producing or handling materials in a factory. Even a slight saving on each unit of production is very properly regarded as worth while. Considering the space occupied by the Employment and Medical Departments and the number of different applicants and employees passing through them, the frequency of use per square foot in these departments is higher than in many other departments in the average plant. A slight saving in time or effort per person is quite as worth while a contribution to the operation of a plant as a saving in handling of materials.

It is trite to remark that good design and equipment are fundamental to such efficient operation. Yet it is astonishing to note how frequently the simple essentials of effective layout are disregarded in these much used departments. Case after case comes to mind,—in one plant, interviewing is frequently retarded and sometimes completely stopped by intermittent distractions in an adjacent passageway; in another, the assistant, and in his absence, the employment manager himself, must go to the next room scores of times daily for records of applicants and former employees because sufficient allowance was not made near at hand to accommodate the files that so rapidly expand in every Employment Department; in another Employment Department, applicants in the waiting room can hear the questions and answers of the clerk and the man he is interviewing; another employment manager must go upstairs to a private room whenever he wishes to talk confidentially over

the telephone or to give a private interview, etc. Movable partitions, of wood or steel frames, are convenient for forming the rooms of Employment and Medical Departments, as they can be used with clear or obscure glass either standard height or extended to the ceiling for privacy.

There are few, if any, so-called "perfect" layouts, as in practically every case some desirable features must be sacrificed because of building, space, or money restrictions, to obtain facilities more essential for the department. Careful analysis should disclose these handicaps beforehand so they can be weighed and provided for in other ways, and not learned with surprise and regret after the layout is built and the new department is in operation. Certain defects in Diagram 1 are evident, due to physical characteristics of the building. The space shown in this layout illustrates the requirements, of an average plant employing around 1,000 people. This area could be made to serve a plant of 2,000 to 2,500 if the frequency or intensity of use was not too great. The layout is a good example of the principle of using the space with natural light and ventilation for those rooms used constantly, or by permanent employees, and using the inside, artificially lighted space for rooms used infrequently, or even continuously by transients rather than by the permanent staff.

Have you ever gone to a plant as a customer to buy their product and entered a sales room that was badly furnished and lighted and that had in general a second-rate appearance? Most companies spend real money in dressing up their front hall so customers will get a good impression of their product. The Employment Department is the "front hall" of a company to great numbers of people who favorably or adversely affect production and profits. Yet too often this department suffers from a lack of arrangement and facilities that belie the real standards and character of the company. Floors, walls, lighting and ventilation should be given particular attention. Examination of many Employment Departments will show that bad impressions are created not so much by cramped space, bad arrangement, second-rate equipment, and lack of toilet facilities, as by floors worn with shop and street grime, hand-marked walls, dull paint, dingy lighting, and stuffy air. These latter defects can be easily remedied and yield a return in appearance and effectiveness on both applicants and employees far beyond the cost.

Medical Department work falls into three groups,—(a) treatment of injuries, (b) medical consultation or care, and (c) physical examinations. The type of service rendered under the first of these three will largely decide where the Medical Department should be located. Where injuries are severe, or of a lesser nature but frequently occurring, the Medical Department should be located as close as practical to the source of the injuries; contrarily, there are several excellent reasons for having the Medical Department immediately adjoining the Employment Department, particularly if physical examinations are given at the time of hiring. Some companies are fortunate in that the Medical Department can be near both the factory sections it most frequently serves and also the Employment Department. Where these two departments must be split, the advantage resulting from having the Medical Department near the needs of the employees usually outweighs the disadvantage to the Employment Department staff and to applicants. Diagram 2 is a layout for a Medical Department located on the second floor, with manufacturing departments on all sides and the Employment Department on the first floor. Natural light is obtained overhead from skylights. The space totals 672 square feet. In Diagram 3 is shown a layout that is adjacent to both Employment Department and manufacturing departments, with six rooms, totalling 900 square feet.

The work of the Medical Department usually requires space for the following, although frequently two or more functions can be combined in one room,—(a) Waiting Room, (b) Physical Examination Room or Booths, (c) one or more Treatment or Baking Rooms, (d) Rest Room, (e) Doctor's Office and Record Room.

Waiting Room. When the calls at the Medical Department can be scheduled and controlled, a very small room will suffice. If scheduling is not practical, a larger room must be provided, and in some cases, two rooms,—one for males and one for females. If physical examinations are given to applicants before hiring, it is bad policy to have them wait their turn in the same room in which injured employees are waiting their call to have wounds dressed. The use of two rooms can sometimes be avoided by using a small passageway or by having the applicants report at hours when no dressings are being given to employees.

Examination Room. The steadily increasing use of physical examinations at hiring requires some definite provision for doing this work quickly and at a minimum of floor space. Two or more small booths, in a room partly used for other purposes, permit the physician to examine one man while the next is preparing. These booths can be as small as 3′ x 4′ or 5′, each one shielded as to sight and conversation. In addition, adjacent open space must be available for scales, eye charts, etc. A distance of 20′ is preferable for use in eye examinations,

but this is not a requirement, as mirrors can be used to obtain the required distance. It is particularly important that toilet facilities be immediately adjoining the examination space.

Treatment Room. The size of the treatment or hospital room varies widely in different companies. Where the injuries consist of slight cuts and bruises, or where complete hospital equipment used by other companies is available in the same building, this room can be kept at minimum size. Where injuries are severe or frequent, or where additional hospital facilities are remote, the hospital room should be ample to take care of peak loads and to accommodate large pieces of apparatus used for extreme cases. Many companies find it more economical in fees and saving of production to equip this room with special apparatus than to send their injured employees outside for treatment. It is therefore advisable to be liberal in allowing space for future needs in this room and to economize on space elsewhere. Whether a special room for baking, massage, or electrical treatments is required, again must be decided by the needs of each company. In most cases, a corner of the hospital room can be screened off to accommodate one or two pieces of such apparatus.

Complete plumbing facilities are necessary in this room,—hot and cold water, drains, gas outlets and electric plugs. A surgical sink is a requirement for the work of most companies and to somewhat lesser extent a utility or slop sink is necessary. Other fixed pieces of equipment may be desirable. All doors leading into the hospital room and in passages giving entrance to the hospital, should be at least 3′ wide to permit ready use of stretchers or wheel chairs for emergency cases. It is still better to provide double doors, using only one door for ordinary purposes. The walls of the room should be closed to the ceiling,—of heavy materials or of glass,—to keep out noise and dirt but more particularly to keep in objectionable cries and odors that have a habit of occurring in the best-regulated families. For obvious reasons the hospital room should be so located as to obtain outside air and light. Floors in the Medical Department, and especially in the hospital room are usually subjected to heavy wear and yet must be kept in first-class condition. It is wise economy to spend a little more for the first cost of a good floor or covering than to run the expense of frequent scrubbings, patching, or painting. Some companies paint the Medical Department walls in warm buff or tan color. This takes away the glaring, white, "operating-room" look, and has a good mental effect on the employees.

Rest Room. Rest rooms are required by law in many industrial localities. Such rooms are particularly valuable where large numbers of females are employed. Whether one or several rooms are within the Medical Department itself, or are scattered through the plant with a matron in charge of each, is a matter of company policy. These rooms should be of such size and shape as to accommodate the required number of 2′ 6″ x 6′ cots or couches at a minimum use of floor space. Toilet facilities should be convenient to each room if possible. If the rest room is within the Medical Department, it should be arranged so the nurse can conveniently supervise it at all times.

Office and Record Room. Space is usually required sufficient for consultation work by the doctor, clerical work by the nurse or clerk, and for file cabinets of records. These activities may sometimes be carried on in the examination room or the rest room, depending on the frequency of use. Some companies with a full time doctor and complete medical service require a separate room for the doctor. It is customary not to have clerical work or filing of records done in the hospital room, but space for this should be located immediately adjoining it. Most Medical Departments are supervised by one person, and it is advisable to arrange all rooms so that their entrances and exits can be controlled by one person from a central location, preferably from the record room or office where the routine work is done. In Diagrams 1, 2 and 3, the nurse at her desk in the record room can control all other rooms in the department.

DAYLIGHT ILLUMINATION OF INDUSTRIAL BUILDINGS

BY

WILLIAM R. FOGG

THE BALLINGER COMPANY, ARCHITECTS AND ENGINEERS

PROBABLY one of the most significant facts now becoming recognized concerning modern commercial, industrial and institutional buildings is that their useful life has been increased during the past quarter of a century by about half. This is evidenced by the change of policy of loaning institutions in increasing the number of years over which mortgage loans may extend, and decreasing the yearly amortization payments on the mortgages. Another evidence is the increasing acceptance by the public of building securities as a conservative and stable form of investment.

An examination of the reasons for this change will show that buildings designed in accordance with modern standards more nearly approach an ideal solution of the problem of requirements of their occupancy than has ever been possible in the past. This is due to the perfecting of materials of construction and their proper use by architects and engineers for the purposes intended. Almost all the desirable requisites in a building of a given type are now obtainable, which was not true to the same extent at the beginning of the present century. Architectural styles may vary in the future as in the past. As far as the utilitarian requirements of a building are concerned, however, it is now possible by skillful use of materials available to obtain a building of permanent construction almost perfectly adapted to its purpose.

What is true of buildings as a whole applies

Interior of Modern Printing Plant for Mack Printing Company, Shown at the Top of Page. Sawtooth Construction with Maximum Daylight Illumination and Super-span Truss Construction, Eliminating all Columns
The Ballinger Company, Architects and Engineers

Clothing Factory, Erected 30 Years Ago. Wall and Window Spaces of Equal Width; 15 feet, 9 inches Story Height; 68 feet, 8 inches Wide

Interior of Clothing Factory, Erected 30 Years Ago, Showing Valuable Lighting Space Lost Above Windows Due to Type of Construction Then Prevalent

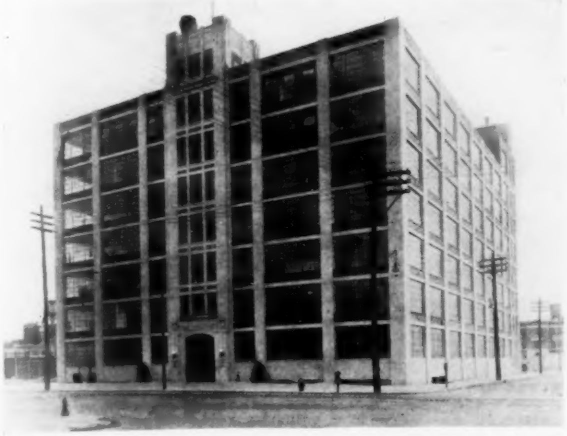
The Ballinger Company, Architects and Engineers

in a notable degree to the important matter of bringing daylight illumination to their interiors. It is now possible to obtain in the side walls of buildings almost any amount of window area which may be required, and the same is true of skylight area in roofs.

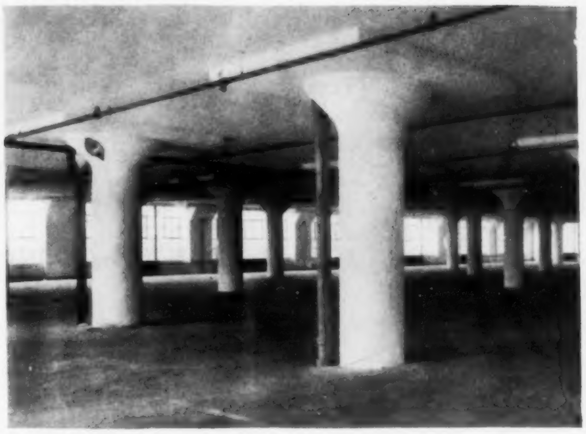
Development of window construction has been along the line of greater area of glass and less width of bars dividing the windows into sections. Protection against the elements, including fire, and suitable means for ventilation, screening, hanging shades and cleaning are well provided. Many improvements have also been made in the production of glass itself to better adapt it to particular requirements. Satisfactory glass is now readily obtainable to meet any need for clearness and surface and for the direct transmission or for the diffusion of daylight. Special glass is manufactured for the purpose of excluding objectionable rays, and there are other forms of glass which permit the passage of beneficial sun rays.

Wall Lighting. Due to the materials of construction commonly in use a quarter of a century ago, the practicable wall openings then available in the average building were much restricted in size as compared with those used at present. At that time the ordinary construction was such that not more, and often less, than 50 per cent of the wall area above the window sills was available for windows. Walls consisted of alternate masonry piers and wood windows, the wall and window spaces being about equal in width. Window jambs were quite deep, due to the thickness of the walls. In this construction the wall piers supported the floor beams, the masonry arches over the windows supporting merely the masonry above them to the window sill above. Because of the wood beam floor construction and the arched heads of the windows, some window area was usually lost near the ceiling where it would have been most valuable. In addition, the projecting beams and girders of the floor construction above prevented the maximum penetration and reflection of the daylight by the ceiling.

With modern construction, the usual average of available wall area for windows is from 80 to 85 per cent. This is made possible by the use of concrete or steel frame construction to carry the floor loads, reducing the wall columns to a minimum width and the window jambs to minimum depth. Window lintels are so constructed that the necessary depth is obtained by the beam extending above the floor instead of below the ceiling. This permits the tops of the windows to be at the same height as the ceiling, and is the ideal lighting condition. With the development of mushroom concrete construction, omitting beams and girders, an entirely flat ceiling is provided permitting maximum daylight penetration and reflection. Where conditions require it, the window area can be practical and economical methods of construction be increased to almost 100 per cent. This is done by using



Exterior of Modern Telephone Manufactory for Western Electric Company, Having Window Area of Between 80 and 85 Per Cent



Interior of the Building, 120 Feet Wide, 12-Foot Story Height, Showing Advantages of Flat Slab Construction, Window Heads Reaching to Ceiling

The Ballinger Company, Architects and Engineers

mushroom construction and having the floor slab cantilevered beyond the columns, placing all columns inside the building and omitting wall columns entirely.

As a result of having the wider windows, made possible by the use of new structural methods, the daylight illumination in the interior of a building is increased more than in direct proportion to the increase in width of the window openings. This is due to the fact that the average illumination is much better with wide windows and very narrow wall columns than with alternate window and wall spacing of approximately equal widths. In general, the doubling of the size of the window is found to almost triple the effective illumination. More important than any increase in width, however, is an increase in the height of a window. As the economical story heights of buildings are somewhat rigidly determined for various occupancies, a variation in this respect above the window sill cannot be great without exceeding the normal cost, so that utilization of all available height is important. This is done to the greatest possible degree with modern construction.

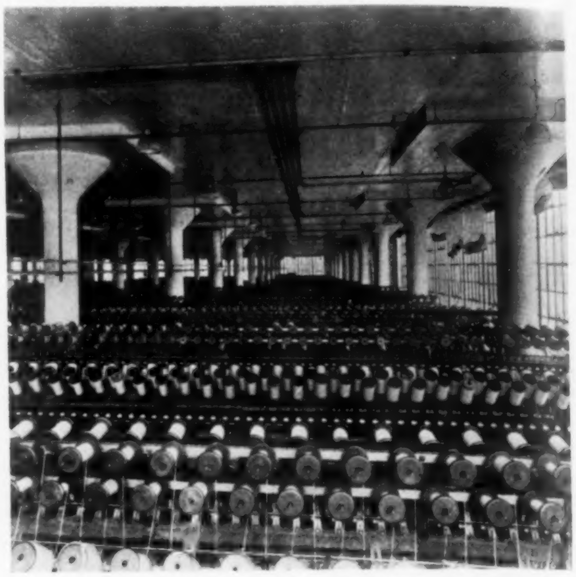
With buildings having an average story height of about 12 feet, the limit of good daylight illumination for average working purposes is reached at about 25 feet from the windows. For distances greater than this, the variation between maximum and minimum is usually more than 3 to 1, which is considered the limit in good practice. For buildings wider than this there remains the choice of increasing the story height, increasing the window area, or using artificial illumination in the more remote areas.

Owing to the fact that light entering the building through the side walls is always influenced by the exposure of the walls in relation to the sun, there results an unevenness of illumination at different times of the day. At one period the illumination is at a maximum, and probably excessive, and at another period it is at a minimum, and perhaps inadequate, except close to the windows. The minimum illumination of a given location therefore determines its availability as working space under daylight conditions. It is estimated that with working hours from 8 A. M. to 5 P. M., in the latitude of New York, artificial illumination is required upon an average of two hours per day during the year in buildings of average width which are dependent upon side wall illumination.

Roof Lighting. To be of the most value for general purposes, light must be as nearly uniform as possible during the whole working period. This uniformity of illumination is best obtained by dependence upon a light source in which there is relatively little variation and which is in all cases at or above the minimum required. This is accomplished by illumination of the building from overhead by a type of construction which will exclude the direct rays of the sun and depend upon the more uniform reflection from the clouds. For this purpose the well known sawtooth skylight type of roof construction is used. It will be evident that if the light is brought through the sides of monitor skylights, instead of through sawtooth skylights, the conditions will be very similar to those which exist with windows in the side walls.

Originally developed for use in textile factories, the sawtooth skylight has been generally adopted by all industries requiring good average daylight without glare. The sawteeth are usually constructed with spans of from 20 to 25 feet when beams are used, and are economically constructed with simple trusses for spans as great as 40 feet. For greater spans a patented type, known as the "super-span" truss, is used, com-

Exterior of Modern Textile Manufactory for James Lees & Sons Company, Showing Almost 100 Per Cent Area of Windows Above Sill Line



Interior of the Factory Showing Elimination of Columns at Wall Line to Obtain 100 Per Cent Window Area: 15-Foot Story Height; 120 Feet Wide

The Ballinger Company, Architects and Engineers

bining two or more sawteeth in one truss to eliminate obstructing posts from the floor area. The glass area in these sawteeth varies with the lighting requirements, being usually between 30 and 35 per cent of the floor area. A difference in practice exists with reference to the position of the glass portion of the sawteeth, some being vertical and others having a slope. When sloping, care is taken to avoid so much slope that direct sun will be admitted to the building. It is unquestionably true that more light will be admitted by the sloping skylight than by the vertical, but as the vertical skylights remain clean much longer than the sloping, it depends upon the cleaning whether one admits more light than the other.

In addition to guarding against excessive slope of the skylight, it is important also that the skylight face directly north, if the sun's rays are to be excluded during the early morning or late afternoon. This is of so much importance that it was obtained at some additional building expense at a plant recently constructed having an area of 1,200,000 square feet of sawtooth roof construction. As the street lines of the lot were at an angle of nearly 90 degrees with the cardinal points of the compass, it was necessary to construct the sawteeth parallel with the east and west diagonal of the building, instead of parallel with the walls. With sawtooth skylights flat glass is most frequently used, although recently corrugated glass has been used with satisfactory results. In either case wire glass should be used for safety considerations, to prevent the hazard of falling glass, injuring employes or machines.

Ventilation of sawtooth skylights is usually effected by having the upper or lower rows of lights, or both, hinged at top and opened outward by means of hand- or motor-operated mechanism controlling any desired length of skylight. With corrugated glass, which is installed without frames, ventilators on the roof are used, or sections of glass are omitted and mechanical ventilating units are installed. In addition to the reflection of the northern sky through the sawtooth skylights, it has been found that the sloping roof of the sawtooth adjoining on the north can be made to reflect some of the light from the south. If instead of slag, which is gray in color and turns dark when wet, white pebbles are used on the surface of the roofing, or a dull-finish white surface roofing is used, an appreciable increase in illumination is obtained. It is estimated that with usual hours from 8 A. M. to 5 P. M., in the latitude of New York, artificial illumination is required upon an average of not more than half an hour per day throughout the year in sawtooth skylight buildings of proper construction.

Window Construction. Wood windows, which were suitable for the small window openings of earlier days, are not well adapted for the larger openings because of the increase in size of members which would be necessary to obtain the same strength as steel. For ordinary commercial and institutional buildings the most commonly used window construction is therefore of metal. Owing to the strength of the metal it is possible to obtain very large glass areas with practically no obstruction from the members

forming the window sash, and there is practically no exclusion of light because of them. Originally metal windows were of hollow sheet steel, but these have now generally been displaced by windows having members of rolled steel or other solid metal construction. Steel windows, owing to their standardized construction and their being made by mass-productive methods, can be obtained for all requirements in a highly competitive market.

Steel windows, unless properly protected, are subject to corrosion and more rapid deterioration than wood and for that reason should be painted at regular intervals. Galvanizing of steel windows and other means of metal protection are, therefore, used at times in addition to ordinary painting. One objection to use of steel windows in the past has been the fact that the metal-to-metal contact was not as tight as with wood, and the heat requirements of the building were accordingly increased, due to air leakage. With the better type of sash, however, double-contact surfaces are provided with an air space between, which greatly reduces the air and heat loss through sash openings. Metal windows are produced in a great variety of designs, of both plain and of artistic types. With them, ventilation is provided in an even greater variety of ways than with the original wood windows.

The double-hung sash, originally the most common, probably because of its wooden prototype, which is either weighted or counterbalanced, with top section sliding down and bottom section sliding up, is much less used than formerly. One objection to the double-hung type is that only half of the window opening is available for ventilation at any one time. This has been overcome by having the upper and lower sash pivoted or sliding in such a manner as to obtain the entire opening for ventilation. The most common type of window now in use is the rigid frame with movable sections pivoted on a horizontal axis, one portion of the sash moving in and the other out. Another design is the projected type, having movable sections hinged on a horizontal axis and projecting inside or outside as desired. Then there is a combination casement and projected sash. This has a section at the bottom hinged at the sill and opening in, providing ventilation without draft, and an upper double casement portion for part or full ventilation when desired.

Cleaning of fixed windows in large areas in factories is only practicable with a scaffold swinging from the outside. Most windows are of the ventilated type, and with pivoted or hinged sash provided with only a single row of fixed panes around the sides, so that it is possible, though not convenient, to clean them through the ventilator openings. Windows of the double-hung type, where not made reversible, are provided with hooks in the frames for the attachment of cleaners' belts when working from the outside. Casement sash are usually cleanable from the inside of the window. Screening of pivoted steel sash openings against entrance of insects at one time presented a difficult problem, usually solved by using an unsightly circular screen. This has been overcome by providing two screens, one above and one below, with spring brass rubbing strips pressing against the sash where pivoting occurs. Conditions of humidity, where condensation is likely to occur at windows, are provided for by means of double glazing and by providing condensation gutters for removal of condensation when formed, without dripping.

Glass. One of the most important improvements in the manufacture of glass on a commercial scale is the new method of producing a flat glass by direct drawing of the sheet from the furnace. A superior product is thereby obtained at a lower cost of production. This process is now rapidly replacing the old method of blowing a cylinder and then cutting and flattening it, with the resultant waviness of surface. Another improvement in glass manufacture was the production of wire glass. With the increase in the glass area in the walls and skylights of buildings there came the need for greater resistance of the glass in order to prevent the spread of fire from one area or from one building to another. This is successfully accomplished by the use of glass in which a wire mesh is embedded to hold the particles together in the event of the glass cracking into pieces. This glass is obtainable in the cheaper rough surface type at a cost of but little more than plain glass, and also in polished plate glass at a moderate increase in cost. Where the exposure is not great, ordinary glass clips and putty are accepted by the insurance companies or authorities, but where glass is likely to crack badly, due to intense heat, glazing angles, securely attaching the glass to the frame around its entire perimeter are required for maximum protection and lowest insurance rates.

Several kinds of glass are now available which have a diffusing action and re-direct the rays of the sun toward the interior of the building. This tends to correct the effect of plain glass where the light adjacent to the window is too bright and where farther away it is insufficient for ordinary working purposes. Care must be taken in the selection of this diffusing glass to avoid that which will cause a glare and an objectionable effect upon the eyes of the workers. Some makes of this glass now available show almost twice as much illumination remote from the windows as plain glass. This type of glass

is preferably placed in the upper window sash only, the lower sash being glazed with the ordinary type of glass. In any event, a row of clear glass at eye height is desirable to enable the employes occasionally to obtain a distant view in order to relieve eye strain.

Until recently it was not realized that the ordinary glass used for windows and skylights was not transmitting to the interior of the building all of the rays of the sun. Extensive experiments have now shown that the ultra-violet rays, which, although invisible to the eye, have a beneficial effect upon the health, are excluded by ordinary glass. Efforts have been made to remedy this deficiency in ordinary glass, and a number of manufacturers of window glass are now producing, under a trade name, a special product which has the characteristic of transmitting as much as from 40 to 50 per cent of the normal ultra-violet rays in ordinary sunlight. This glass is being produced in increasing quantities with a corresponding reduction in cost, so that at the present time it can be obtained at a cost for the material of only from four to five times that of the ordinary window glass. It is slightly more transparent than ordinary glass. Use of ultra-violet rays glass was at first restricted largely to the sun parlors of hospitals, sanitariums, and similar buildings, but more recently it has been introduced into commercial and industrial structures, a notable instance being that of the new plant of the Watson Stabilator Company of Philadelphia. Another type of glass, as well as preventing the entrance of the heat rays of the sun, prevents the injurious effect of the actinic rays upon certain classes of colored materials and eliminates eye strain due to glare.

Owing to the glare and heat of the sun's rays, it is frequently necessary to provide some form of protection for windows exposed to the direct rays of the sun in the morning or afternoon. One of the most inexpensive types of shades for providing ventilation consists of a series of wood or fiber strips fastened together at intervals and raised or lowered by means of cords, the shade rolling at the bottom as it ascends. Another type, somewhat more expensive, provides for greater flexibility of the light and air and is a modification of the Venetian type of blinds, which can be arranged to direct the light upward toward the ceiling, preventing glare and at the same time providing ventilation. One method of providing against the discomfort from the direct rays of the sun is to use a semi-transparent paint applied to the surface of the windows, usually of a bluish tinge. This has the effect of preventing glare and also of preventing the entrance of the heat rays of the sun, thus to some extent reducing the heat in the interior without unduly diminishing the amount of light.

An important adjunct to the proper illumination of a building, whether by daylight or artificial light is the proper painting of the walls and ceilings. Numerous paints are available for this purpose, it being chiefly important that the paint be of light color to reflect rather than absorb light, and that it will adhere and not change color after application.

From this it will be evident that methods and materials of construction are available for solving practically all the problems in the bringing of daylight illumination inside the building. There will, however, always be the necessity for services of skilled architects and engineers in the study of any given building problem to insure the application best suited in that particular case.

Interior of Modern Radio Manufactory of Atwater Kent Manufacturing Company, Using Super-span Sawtooth Skylight Showing Reflecting Value of Light Colored Roofing Material on Slope of Adjoining Sawtooth

The Ballinger Company, Architects and Engineers

ARTIFICIAL ILLUMINATION OF INDUSTRIAL PLANTS

BY

A. L. POWELL

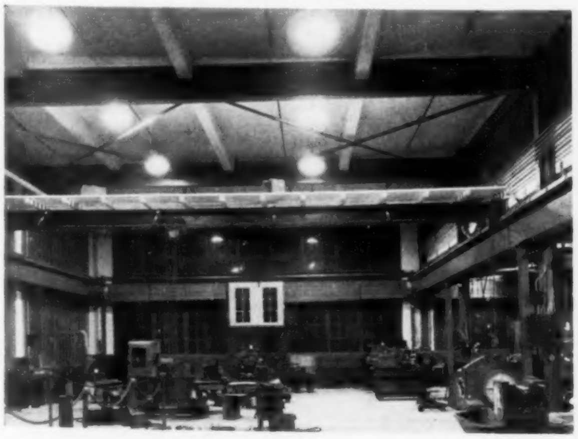
ELECTRICAL ENGINEER

WHEN one pauses to view the advance of civilization, one is greatly impressed to find how inter-related and inter-dependent are the various elements which combine to produce a given result,—how one great advance hinges on development in some other field of activity, and how man or nature seems to rise to the occasion and provide what is necessary for outstanding economic changes.

If an economical, reliable, convenient and powerful source of artificial light were lacking, work at full efficiency would be possible only in the hours of sunshine, and all machinery would have to be placed so that it would receive daylight. Fifty years ago there were available to light the industrial plants only weak, flickering candles, oil lamps and gas burners, and if these only were available today we would not be living in the industrial age. There can be no doubt that the introduction and rapid development of electric lighting is one of the very foundation stones of this twentieth century progress. Space does not permit a discussion of the fact that proper lighting does increase production, reduce shrinkage, promote safety and health, and keep the worker in a cheerful, contented frame of mind.

In brief, the industrial plant should be illuminated throughout to such a level that the worker can see the necessary detail quickly, without overtaxing the eyes. There must be no violent contrasts in brightness, no bright light sources in the field of view, and no glaring, annoying reflections from polished objects. One of the most important questions is,—what constitutes the right amount of illumination? A study of the functioning of the eye with increasing illumination shows a rapid improvement in visual acuity in the lower range of foot-candle values, and a much lower rate at higher levels. It must be borne in mind that such tests are generally based on the observation of black objects on white backgrounds, and in the industrial plant it is rare that these conditions prevail. Generally, the things to be seen are of varying shades of gray, with much less contrast, so that the standard visual acuity curves are much higher on the scale. Investigators do not really know where the upper limit lies. Plants which a few years ago were content with an illumination of 5 foot-candles have gone through the stages of providing 10, 15 and 20 foot-candles, and the most progressive are now demanding even more light for truly efficient operation. We cannot determine just how much light to supply in industrial plants from purely theoretical considerations, since tests of actual installations show that increased output is obtained as more light is supplied. There seem to be several features which have not yet been fully analyzed.

As we supply more and more foot-candles, other complications are introduced. The higher wattage lamps required are considerably brighter than those previously used. Additional precautions must be taken, therefore, to diffuse the light and reduce contrasts. With the present conditions as to ceiling heights and factory arrangement, using the commercial types of reflecting and diffusing devices, the limit of thoroughly



Machine Shop. Medium fine work. 500-watt white bowl lamps, dome reflectors. Outlets spaced 18 x 18′. Lamps 23′ above floor. Ceiling 25′. Ceiling white, walls glass. Illumination level 20 foot-candles.
Goss & DeLieuw Machine Company, New Britain, Conn.

Hardware manufacturing. Blanking punch presses. 150-watt white bowl lamp, dome reflector. Outlets 10 x 10′. Lamps 8′ 6″ above floor. Ceiling 10′. Walls and ceiling white. Illumination level 12 foot-candles.
Russell & Erwin Co., New Britain, Conn.

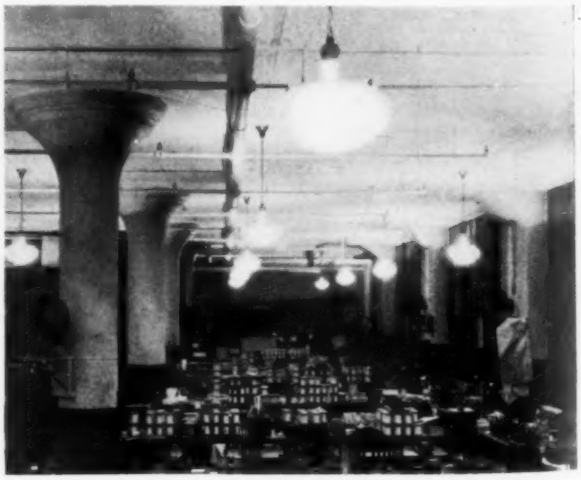
Textile mill. Spinning. 300-watt clear lamps, diffusing globes. Outlets spaced 14 x 21'. Lamps 12' above floor, ceiling 14'. Ceiling white, walls principally glass. Illumination level 8-foot candles.
Chicopee Mills, Chicopee, Ga.

Textile mill. Rough fiber carding. 200-watt white bowl lamps, dome reflectors. Outlets 16 x 15'. Lamps 14' above floor. Roof trusses 16'. Ceiling white, side walls white and glass. Illumination level 10 foot-candles.
Valway Mills, La Grange, Ga.

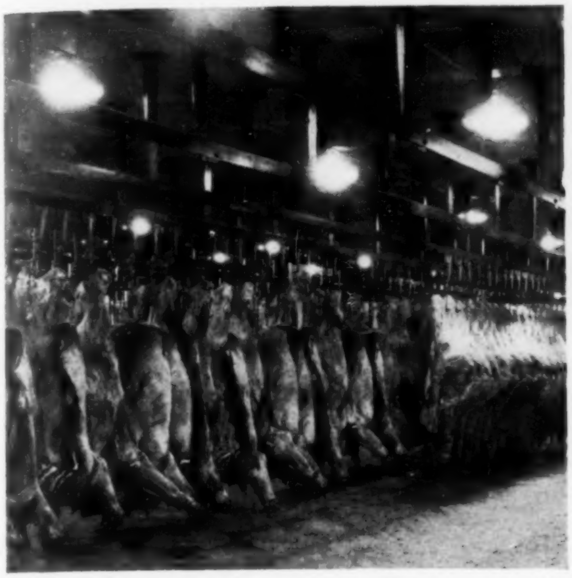
comfortable general artificial illumination seems to be in the neighborhood of 50 foot-candles. As we go above this value the installation is likely to become so glaring that many of the good effects of the higher level illumination are nullified. There is no doubt that when the demand for more artificial light is very general, the ingenuity of the scientist and engineer will come to the fore and will devise adequate ways and means of meeting the situation in all respects.

Common sense dictates the installation of a moderate level of general illumination (10 to 20 foot-candles) throughout the plant, supplied by uniformly spaced overhead units which are equipped to properly diffuse and distribute the light. This should be supplemented by peaks of high level illumination (100 foot-candles and upwards) at working points where fine detail is to be observed. There are many forms of reflectors for general illumination. The types most applicable to the industrial plant are: A standard dome reflector with bowl white lamp.

Electrical manufacturing. Electro-plating department. 300-watt clear lamps, diffuser. Outlets 12 x 12'. Lamps 15' above floor. Ceiling 18'. Ceiling white. Walls glass. Illumination level 12 foot-candles.
General Electric Company, West Philadelphia Works.



Instrument manufactory. Coil winding. 500-watt clear lamps. Luminous bowl, indirect lighting fixtures. Outlets 9 x 17'. Lamps 9' above floor. Ceiling 12'. Ceiling white. Walls glass. Illumination level 20 foot-candles.
Leeds & Northrup Co., Philadelphia



Meat packing plant. Cold storage and sales room. 60-watt lamps, shallow dome, porcelain enamel reflectors. Outlets spaced 4′ 6″ x 8′. Lamps 12′ above floor. Ceiling 13′. Ceiling white, walls white. Illumination level 12 foot-candles. Cudahy Packing Co., Norfolk, Va.

Flag manufacturing. General lighting 500-watt white bowl lamps, dome reflector. Outlets 20 x 20′. Lamps 13′ 6″ above floor. Ceiling 14′. Ceiling, walls white; illumination level 10 foot-candles. Local lighting 15-watt lamps. Annin & Company, Verona, N. J.

Diffuser with clear lamp.

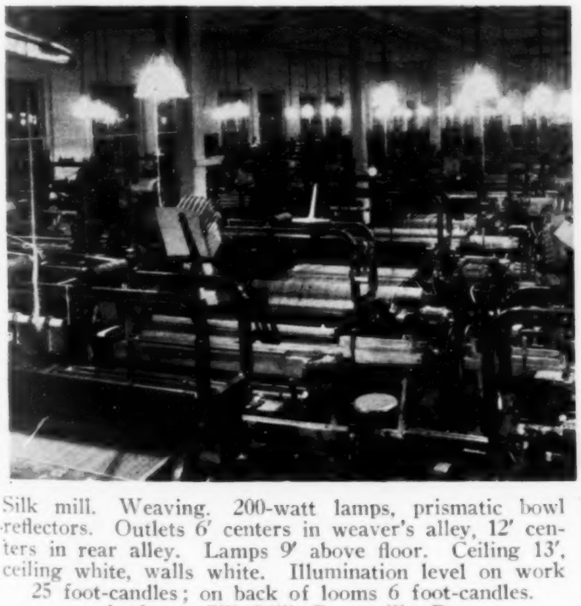
Prismatic glass bowl-shaped reflector with clear or white bowl lamp.

Mirrored glass bowl reflector, clear lamp.

White glass enclosing unit, semi-indirect and totally indirect equipments are also applicable to factory use provided the surroundings have good reflective properties.

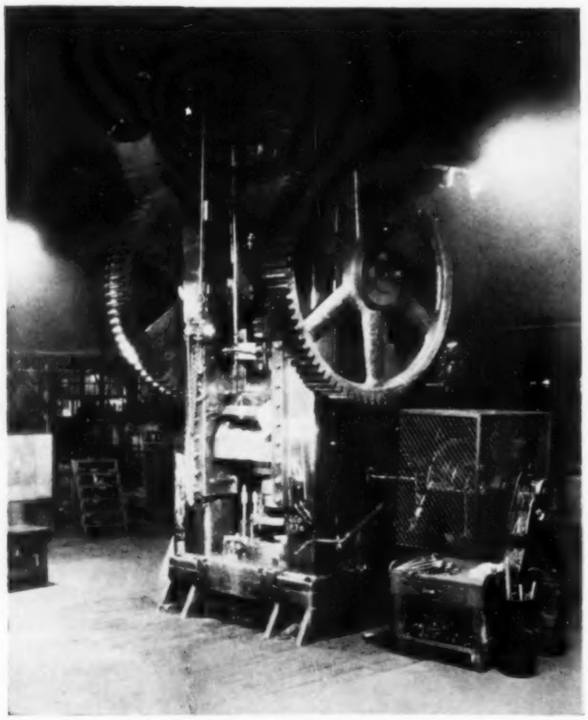
A discussion of the characteristics of the different forms of equipment, their efficiencies, their effect on the appearance of the lighted room, their method of preventing direct and reflected glare, type of shadows produced, and the ease of maintenance, would require several of these pages. All these factors should be given consideration in making a selection, and the handbooks on lighting practice present careful analyses of the relative merits.

In designing a building one is frequently unaware of the future requirements for lighting. A structure may be planned to be a storehouse, and a few years later changed conditions may



Silk mill. Weaving. 200-watt lamps, prismatic bowl reflectors. Outlets 6′ centers in weaver's alley, 12′ centers in rear alley. Lamps 9′ above floor. Ceiling 13′, ceiling white, walls white. Illumination level on work 25 foot-candles; on back of looms 6 foot-candles. Arohnson Silk Mill, Coatesville, Pa.

Color printing. Press room. General illumination. 300-watt clear lamps, diffuser. Spacing 12 x 12′. Lamps 12′ above floor. Ceiling 14′. Illumination level 18 foot-candles. Projector type equipment with 200-watt daylight lamps. Color identification unit at inspection table. Waverly Press, Baltimore



Close-up view showing the application of a projector type unit (or intensifier) for giving high level local lighting at a 1200-ton straight side power press. Federal Pressed Steel Co., Milwaukee

cause it to be used for manufacturing processes. It is much more expensive to re-wire a building than to install adequate wiring when it is being constructed. Not knowing definitely the future of a structure, the architect or designing engineer should provide an adequate number of overhead outlets, plus a sufficient number of circuits with wire of suitable size to take care of normal demands for lighting. If a given area is used as a storage space or for rough work, 100-watt lamps on each outlet may be adequate, whereas, if fine machine work is carried on, 300- or even 500-watt lamps may be necessary. A reasonably safe general rule to follow is to space outlets no farther apart than the height of the ceiling. Thus in a normal loft building with 10- to 15-foot ceilings, there should be four outlets in each typical bay. With the advancing standards of illumination, inadequate wiring is being found more and more often to be an obstacle toward providing the lighting which industrialists need and desire. In some instances the cost of re-wiring puts a serious burden on a projected improvement. In others, the voltage drop in the existing wiring not only causes an expensive waste of energy and poor regulation but actually reduces the illumination below the expected level. This situation is so serious to the users of light that the National Electric Light Association, through its Commercial and Industrial Lighting Committee, has undertaken activities to call attention to the importance of this matter and aid the lighting service engineers of its central stations in assisting architects and others in the specification of such wiring as will meet the probable requirements of the near future. A committee of experienced illuminating electrical engineers has prepared specification paragraphs covering the quantity elements.

The specifications are based on the use of 15-ampere fusing on branch circuits and, to quote, it is suggested that: "In no case shall one branch circuit for overhead lighting supply the lighting for a work space or rentable area greater than 400 square feet or a bay approximately 20 x 20 feet, or shall one branch circuit for overhead lighting supply more than 800 square feet of hall or passageway or other non-rentable or nonproductive area. Based on the wattage of outlets specified on the plans, branch circuits shall be so arranged that the load on a circuit shall in no case exceed 1,000 watts, except in a case of a single lamp of larger size."

In these paragraphs the size of wire is specified with respect to the length of run by two sizes, namely, Nos. 10 and 12, B. & S. being recommended. Other features treated are panel boards and feeders. This method of specification conforms to ordinary wiring practice except that a higher standard is called for. It has the further advantage of clearness and definiteness, which enables a non-technical man to check compliance accurately. The wiring specified in this manner will carry the next larger size of incandescent lamp without excessive lowering of voltage. This feature, while relatively inexpensive, is likely to result in large future economies for the owner and user. If adequate wiring and a reasonable number of outlets are installed, the problem of correct lighting is quite simple. The owner or lessor can install the coördinated size of lamp and reflector to meet his special requirements.

The accompanying illustrations are from night photographs of installations which are considered as representative of good practice today. In the captions are presented reasonably complete details, so that each illustration really represents the solution of a typical lighting problem.

HEATING AND VENTILATING OF INDUSTRIAL BUILDINGS

BY

WALTER E. HEIBEL

OF VOORHEES, GMELIN & WALKER, ARCHITECTS

IN the early days of the factory system, chief importance was attached to the *quantity* of output, and little attention was paid to the employes' comfort or to the *quality* of the product. But as time passed a comfortable working space was soon recognized as being essential, and the proper heating of industrial plants became more and more standard practice. Today the heating system is always considered along with the design of an industrial building from its very inception. The large number of concerns now manufacturing factory heating equipment bears witness to the universally high standards found in heating systems. Ventilation and air conditioning are likewise of prime importance and should receive the same care and foresight as the heating work, but due to the highly specialized nature of the control of humidity, etc., this problem is usually left to the specialist for solution.

For the average industrial building the owner has the choice of any one of three types of heating systems. Broadly, they can be classed as: (1) fan system; (2) direct steam; (3) direct hot water. The fan system has been placed at the head of the group for the reason that experience has shown this type to be well adapted to the average manufacturing plant. Under the classification of fan systems there are two different types to consider: (A) the unit heater system of heating, and (B) the central system of heating.

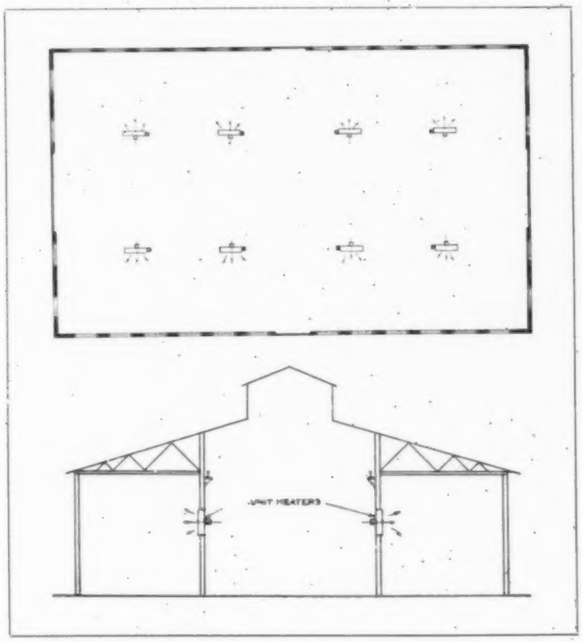
With the unit heater system the space to be heated is equipped with one or more units, each consisting of a fan and heater. Refinements have been added to some makes of equipment in the form of air filters and humidifiers, but the units which meet the demand of average service need only a heating element and a fan for distributing the heated air. This equipment is designed either as wall-mounted or floor-mounted units. Various sizes are available, so that almost any combination of space and other conditions can be met by standard equipment. In the floor type of unit the capacities range from about 3,000 c.f.m. to about 10,000 c.f.m. of air delivery. Standard wall-hung units generally run smaller in size and air delivery. It is the practice of manufacturers to give their equipment a catalog rating in B.t.u.'s per hour or equivalent surface for direct radiation in order to facilitate the choosing of the proper sizes.

The customary method for figuring the B.t.u. loss from a building is followed, and from this value the size and number of units for the building can be determined. By dividing the total heat loss by 240, the equivalent square feet of heating surface can be determined. Special units are obtainable to meet unusual demands, and in such instances, it is best practice to design heater and fan for the requirements.

The proper air heater may be chosen from the published data of any of the air heater manufacturers. In making this choice the air heater must be sufficient to heat the air from its temperature entering the heater to the temperature of the heated space plus the degrees of diffusion (H-h), where H=temperature of air leaving unit heater; h=room temperature. When air is re-circulated, the heater must then theoretically supply only the heat of diffusion, representing as it does the transmission losses. The fan may be chosen from the catalog data of any reliable fan manufacturer, giving volume, horse power, etc.

For the ordinary heating project it is satisfactory to figure that all air is re-circulated. The only factor involved which would demand outdoor air being admitted is that of ventilation, and ventilation requirements in factories are usually met satisfactorily by the ordinary leakage through windows and doors. Where the occupancy is highly concentrated, or where processes employed demand it, forced supplying of fresh air is effected by means of connections, directly through the building walls in convenient locations, or by utilization of a portion of the window openings. It is desirable in any event to provide dampers in order that the quantities of fresh air and re-circulated air can be controlled. Floor type units are preferable for the average industrial plant for the reason that they can be obtained in larger sizes, thus requiring fewer units, less piping and lower maintenance cost. As a practical consideration, use of any equipment which can rest on a solid floor generally simplifies the installation work. Floor space is seldom so valuable that a few square feet cannot be allotted to the heating equipment.

Heat distribution can be effected easily by maintaining high outlet velocities from the heater openings and thus create a general motion of the air in the heated space. This general air movement is highly desirable for its effect upon the employes' comfort, providing that a direct blast of air upon any one is avoided. Very satisfactory results also are being obtained by



A Good Arrangement of Wall Type Unit Heaters for Satisfactory Heat Distribution

the smaller units which lend themselves well to suspension from walls, girders, or other parts of the building structure. These units are of very simple construction, usually with the heater and propeller type fan-mounted in a sheet metal casing, and with the fan wheel mounted directly on the shaft of a small fractional horse power motor. These units are used to considerable advantage in augmenting the heating effect of other forms of systems, for warming cold spots which occur near large doors, the opening of which is necessary for the passage of material.

In the cheaper grade of buildings, the direct-fired unit heater has found some favor. With this equipment fuel is burned directly in the unit and the heat transfer is made directly from the hot flue gases to the air which is being circulated by the fan through properly designed air passages. There are many obvious objections to any form of direct-fired heater, among which are the fire hazard involved, the easy access and resultant tampering by unskilled operators, the untidiness which generally surrounds a furnace regardless of what fuel is used, and the high maintenance and operating costs.

Central Heating. For a great many years, before the advent of unit heaters, the principal source of heating in industrial buildings was the central heating plant with a system of distributing ducts for conveying the heated air to the various parts of the building, running through the structure overhead, or in trenches underground. This system generally averages higher in cost than the unit system, but it shows some economies in operation and maintenance. Where careful control of atmospheric conditions is necessary, or where special ventilation is desirable, this system is preferred. In such buildings as lithographic plants, hat factories, textile mills, and manufacturing plants for candies and food products, temperature, humidity and air movement are all important and can be maintained with remarkable accuracy by means of a central heating plant with control equipment.

The central heating plant consists essentially of an air heater and a system of distributing ducts. To this is added an air filter, if cleanliness in the building is important. The design of the system provides openings and dampers for re-circulation of the major portion of the air, and in very large plants, or where the heating plant is isolated from the heated space, ducts for returning air to the heating plant are installed. Distributing ducts are attached to the heating equipment for conveying the air to the various parts of the building. These ducts are usually installed overhead in the roof trusses

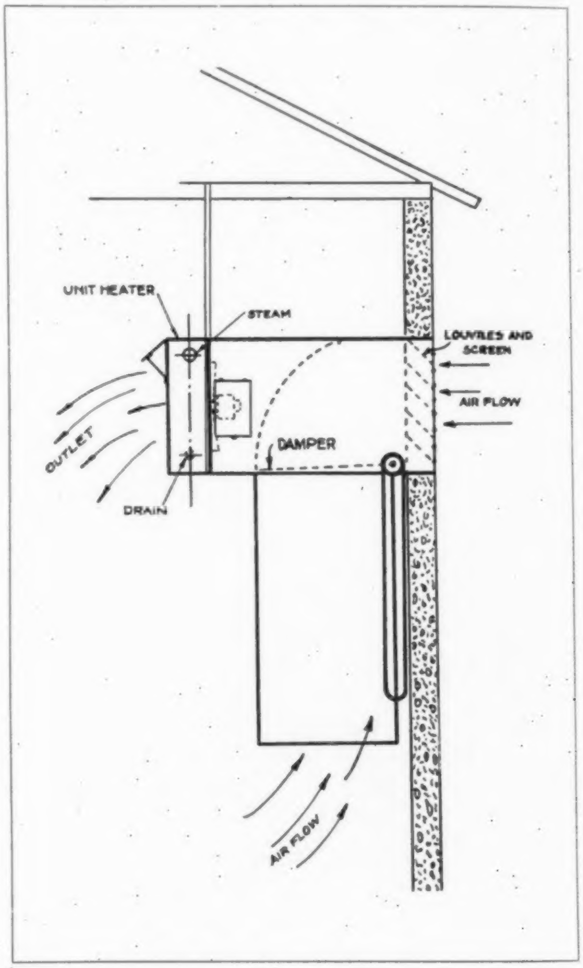


Diagram Showing Air Flow in Unit Heater Equipped with Damper for Re-circulation

Floor Mounted Heaters in an Industrial Building

or along the ceiling, but convenience occasionally requires that they be placed underground. The velocities maintained throughout the ducts are relatively low in order that the frictional resistance against which the fan must operate will be low enough to prevent excessive horse power requirements for the fan. With large installations, duct velocities of 2,500 feet per minute to 3,000 feet per minute at the fan outlet are usual, with a gradual lowering of velocity to about 800 feet at the last outlet; but with smaller duct systems, or where preventing noise is an element, 2,000 feet per minute velocity should not be exceeded. In some manufacturing plants, both supply and exhaust fans are employed. With such systems, the outlet of the exhaust fan is connected to outdoors through an exhaust hood and also connected through a duct with the intake side of the supply fan for re-circulating a portion of the exhaust air.

The design of the duct system should be made only after a careful study of the building and equipment plans. A carelessly designed duct system usually results in there being made a series of subsequent changes which may materially alter the original intent and purpose of the system, or involve a series of price "extras."

The location of ducts should be such that the heated air from the supply outlets may blow toward the outer walls as well as toward the center where it can overcome most effectively the heat losses from the building. The design of the ducts and distribution outlets should be carefully considered to determine the best means of insuring suitable temperatures at the breathing line without overheating the upper part of the floor or building and thus cause an excessive heat loss through the roof. Frequently the upper section of a building is merely a storage space for unused heat, and only a well designed distributing system can place this heat in the zone where it will be of use to the occupants.

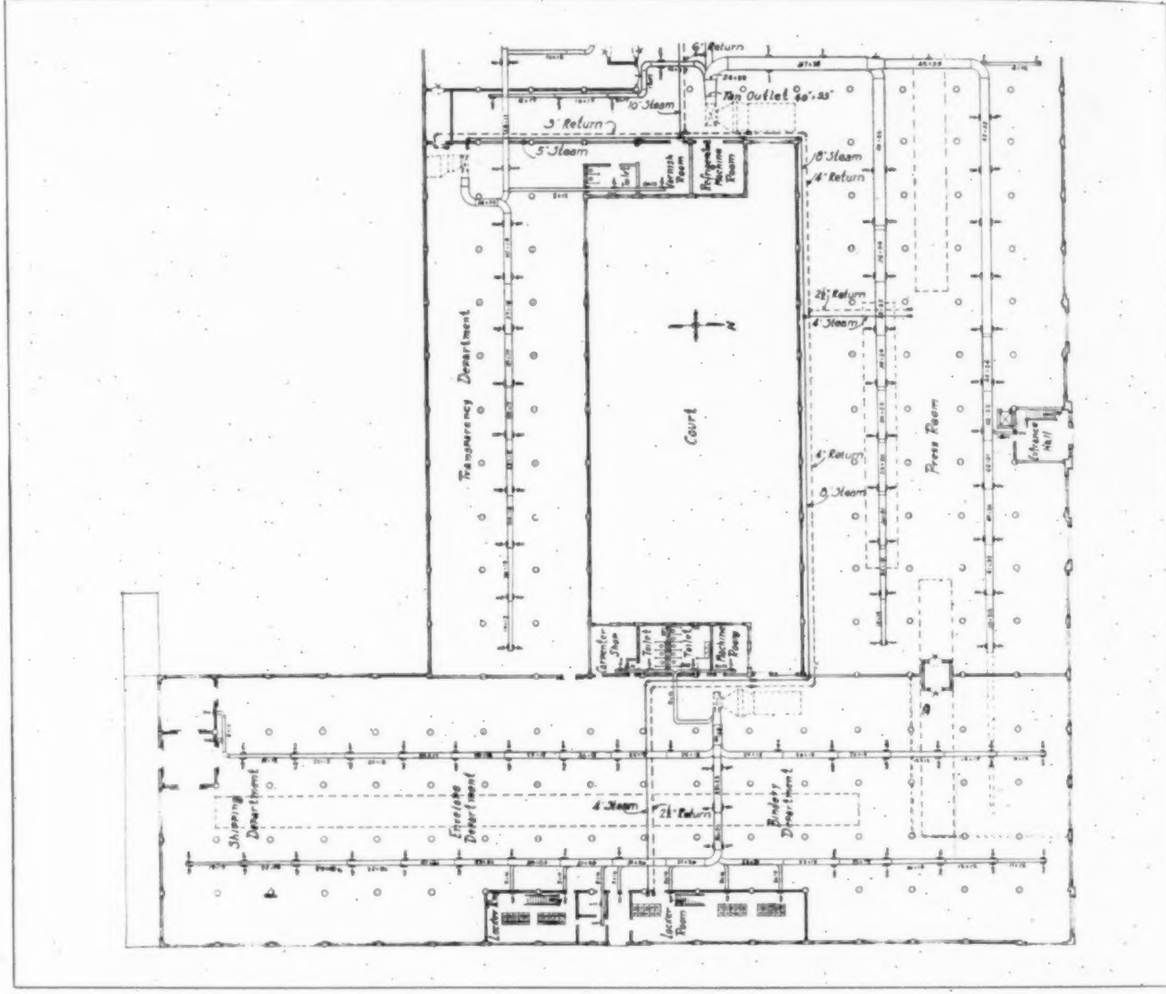
In calculating the size of equipment necessary, the procedure is first to calculate the total heat loss from the building; this loss includes the total B.t.u. per hour transmission plus window and door leakage. The next step is to determine the volume of air to be circulated from the formula:—

Cubic feet of air per minute=B.t.u.÷[.2375x .074x60x(H-h)] where:

H=Temperature of air leaving heater, minus duct loss;

h=Room temperature.

It is customary to design the heating systems for industrial plants to maintain a temperature in zero weather of 60° within the building. The loss of heat in the air passing through the ducts from the heater to the supply outlets in the building is generally represented by a temperature drop of 10 degrees. In choosing the air heater an actual velocity through the heater of from 1,000 feet per minute to 1,200 feet per minute should not be exceeded, and the heater should be ample in size to care for the heavy load imposed upon it during the warming up period. The operation of a fan system of heating is usually intermittent, for it has been found that with the exception of a few unusually cold and windy days, a few hours' operation per day is sufficient. Where variable speed is possible for the fan, economies can be effected by cutting down the flow of heated air after the building has been brought up to temperature. This is particularly true when the steam supplied to the air heaters is taken from a common supply for various purposes, and the operation of the boilers is continuous. Where the boiler load is purely



Duct and Equipment Layout for Air Supply and Distribution in the Plant of the American Lithographic Company, Buffalo

one of heating, the most economy can be obtained by completely closing down the heating system and banking the fires in the boilers.

Direct steam heating is very commonly used in buildings of any nature, and for industrial plants it is found most frequently in multiple-story buildings. Radiators of the wall type have been found preferable to pipe coils or column type of radiators for the reasons that they can easily be installed with the least infringement on floor space, and have a very good heat emission factor. Care should be used in installing radiators to keep them far enough from the walls to insure a good circulation of air between the radiators and the walls, and thus prevent an excessive heat loss through the walls. Trombone coils and header coils have been used extensively in the past, but are not found so frequently in modern installations. Difficulty in keeping any pipe coils tight and problems of drainage preclude their more general use. Steam is supplied to the radiators at low pressure (0 pound to 2 pounds), and the usual two-pipe system with vent and return traps through which return condensation passes to the boiler is generally used. A separate drip line is used where risers require it or where the mains are sufficiently large to make it desirable. In many buildings it is desirable to use a vacuum pump and receiver in place of the return and vent traps, and a vacuum is carried on the return mains which insures rapid circulation and positive return of the condensation.

Except in multi-story buildings, basements are rarely found in industrial structures. Therefore, in order to avoid using trenches, which are always undesirable, the customary method is to place the steam mains under the roof and feed the steam down to the radiators. The return mains are located beneath the radiators and graded back toward the boiler room. Supply valves of the packless type should be used on

the radiators, and thermostatic traps should be installed on the return ends of all radiators and coils. Provision should be made for dripping the heat risers when radiators are shut off.

When possible, roofs should be insulated, for the loss of heat transmitted through the roof can be minimized to a degree that will easily offset the expense involved. On buildings having flat roofs, insulation is essential in order to obviate the necessity of installing an excessive amount of radiation on the floor directly beneath the roof. Roof insulation has the added advantage of keeping out excessive heat during the summer months. On buildings several stories in height, an upfeed system is preferable for the reason that the natural tendency for heat to rise makes the heating for the lower floors more difficult than for the upper floors, which, due to the flue effect, receive considerable warm air through stairways, shafts, etc. Air leakage is inward on the lower floors and outward on the upper floors. This condition, obviously, is modified by wind and exposure.

Vacuum Systems. Very recently, specially controlled vacuum systems have been developed for meeting the varying heating requirements within a building. A source of great heat waste has existed through overheating during the milder weather prevalent in the fall and early winter, and in the spring. With the ordinary vacuum system, steam at approximately the same temperature and amount continually fills the radiators. Since the radiation is calculated to provide the necessary temperatures in the most severe winter weather, generally assumed as zero, with a 15-mile per hour wind blowing, this same heating effect will be too much for the average day encountered during the heating season. Therefore, any equipment which will moderate the intensity of the heating effect of the radiators is highly desirable, and it is with this thought in view that certain manufacturers of heating specialties have developed the equipment just referred to. In one typical method of regulation the amount of steam fed to the radiators is controlled, and in another method the temperature of the steam is controlled by varying the absolute pressure at which steam is furnished the radiators. For instance, the temperature of steam at 2 pounds' gauge is about 216°, and at 18 inches of vacuum is approximately 177°. Such heat regulation should effect very great saving in fuel consumption when the operating engineer has knowledge and full understanding of its merits and limitations, and it should be considered in every installation where vapor systems are being planned.

Hot water heating for industrial plants in many ways is ideal for the reasons that temperature regulation is made simple by means of varying the water temperature, and convenience in piping can be arranged when forced circulation is used. In very large plants and groups of buildings, forced hot water heating has been, and still is, largely used, but the installation costs are greater than for other systems.

Exhaust steam is frequently available for heating industrial plants. It is usual to assume that the economies thus obtained are very great, but in practice it is rarely possible to use the exhaust steam to anywhere near its maximum effectiveness, unless the chain of circumstances surrounding its use is just right. For instance, the maximum demand on the heating system comes during the warming-up period, or before the plant assumes operation for the day. During this interval there is no exhaust steam available. When exhaust steam is available, later on, the demand for heating is so low that little steam is required. It is found to be very difficult to so regulate the heating requirements that they will fit the exhaust steam supply, and in order to utilize this steam to its fullest, additional control equipment is necessary and high maintenance cost is the result.

Air Conditioning. Any discussion of the control of the atmospheric conditions in an industrial plant should include air conditioning. Furthermore, this discussion should include a study of the effect of this control, not alone on the comfort of the employes, but on the product as well, for it is only by such means that good over-all efficiency can be obtained. The stepping up of production has made necessary new and better manufacturing machinery. Machines in the hands of skilled designers and builders have become more or less perfected. Competition in price and quality has demanded further improvement in production methods, and attention has been concentrated on the elements other than machines and operators which affect the product.

The general conception of air conditioning includes, in addition to temperature control, full control of humidity and air distribution. Where temperature control generally contemplates a heating of the air during the winter months, it necessitates a cooling of the air during the warm summer months. Absolute humidity, low during the winter months, requires an increase of moisture in heated spaces, and humidity, relatively high during the summer months, generally requires a decrease if air temperatures are lowered. Control of humidity and air movement as it affects the comfort and health of employes is equally desirable in all manufacturing establishments, where the occupancy is of any great density, but in textile mills, candy plants, bakeries, match factories, paper mills, and many other

plants, such control is essential. The physical properties of many products are materially changed with changing moisture contents. Anyone observing the condition of a carding room in a textile mill after a period of shut down of humidifiers, and with heat still maintaining regular temperatures, can testify to the havoc that can be wrought with valuable materials.

The full air conditioning unit consists of a fan, heater, filter, humidifier (or de-humidifier), and the auxiliary equipment such as refrigerating machine, pumps, motors, control equipment, etc. The plant may be arranged as a single central system to provide air conditioning to the entire factory, or it may be arranged in multiple units, each complete in itself, and designed to provide control over a certain section of the building. Where varying conditions in the plant exist, or where rooms are partitioned off, the unit system is very desirable, but before either a central system or a unit system is decided upon, a very careful check of all fundamental data affecting the system should be made. In some processes, it is more convenient to segregate the humidifier from the other equipment and install humidifier heads in the building, or to provide humidity evaporating pans at convenient locations in the duct work.

Where humidity conditions require a lowering of the wet bulb temperature of the air below the dew point, refrigeration is necessary. In view of the great expense involved in the operation and maintenance of a refrigerating unit, it is essential to maintain as high a degree of temperature as possible, consistent with comfort and health and effect on the product, in order to keep the quantity of refrigeration used at a minimum. The heat-absorbing capacity of the refrigerating equipment must be sufficient to overcome all heat transmission and leakage quantities, in addition to the lowering of the temperatures of the incoming air with its resultant water vapor, condensate and latent heat of water vapor. This means that the temperature of the air must be cooled down a considerable amount below the final desired temperature, so that as the transmission and leakage gains are being met, the temperature of the air is being drawn closer and closer to the final room temperature mark. It is not uncommon to find cases where the transmission and leakage gains are insufficient to insure a proper final temperature and humidity in the building, and therefore a re-heater is always installed which provides any makeup heat that is necessary. A typical installation of air conditioning equipment is shown here, making clear the design of the fan, heater, humidifier and distributing ducts. This installation was made in a lithographing plant.

Automatic temperature control for the heating system in the average industrial plant is not essential, and it is rarely installed except where some processes make it desirable, or where fully automatic air conditioning plants are employed. Pneumatic systems of temperature control are most commonly used. For direct radiation systems there are types of electric thermostats and direct-acting valves which are sometimes used.

There are now on the market a number of direct-control valves for two-pipe direct heating systems, where this new device replaces the supply valve on each radiator. These valves are provided with a thermostatic element in the valve and depend in performance upon the circulation of air through them. Although these valves may properly be said to have passed the experimental stage, they are all too new to rely on as implicitly as would be the case had they a better background of use. A truly modulating valve has also been developed to accomplish some degree of heat regulation. This valve is more in the form of a supply radiator valve, but inwardly is so designed as to give minute throttling and steam distribution in the radiator. This valve, although depending entirely upon manual control, can become an element of no little heat saving with a little interest and experience on the part of the engineer. A key-operated valve is desirable in order to prevent any tampering with the engineer's adjustment by inexperienced men.


A Unit Heater Designed for Floor Mounting

PRACTICAL PLANNING FOR THE FACTORY CAFETERIA

BY

VINCENT R. BLISS

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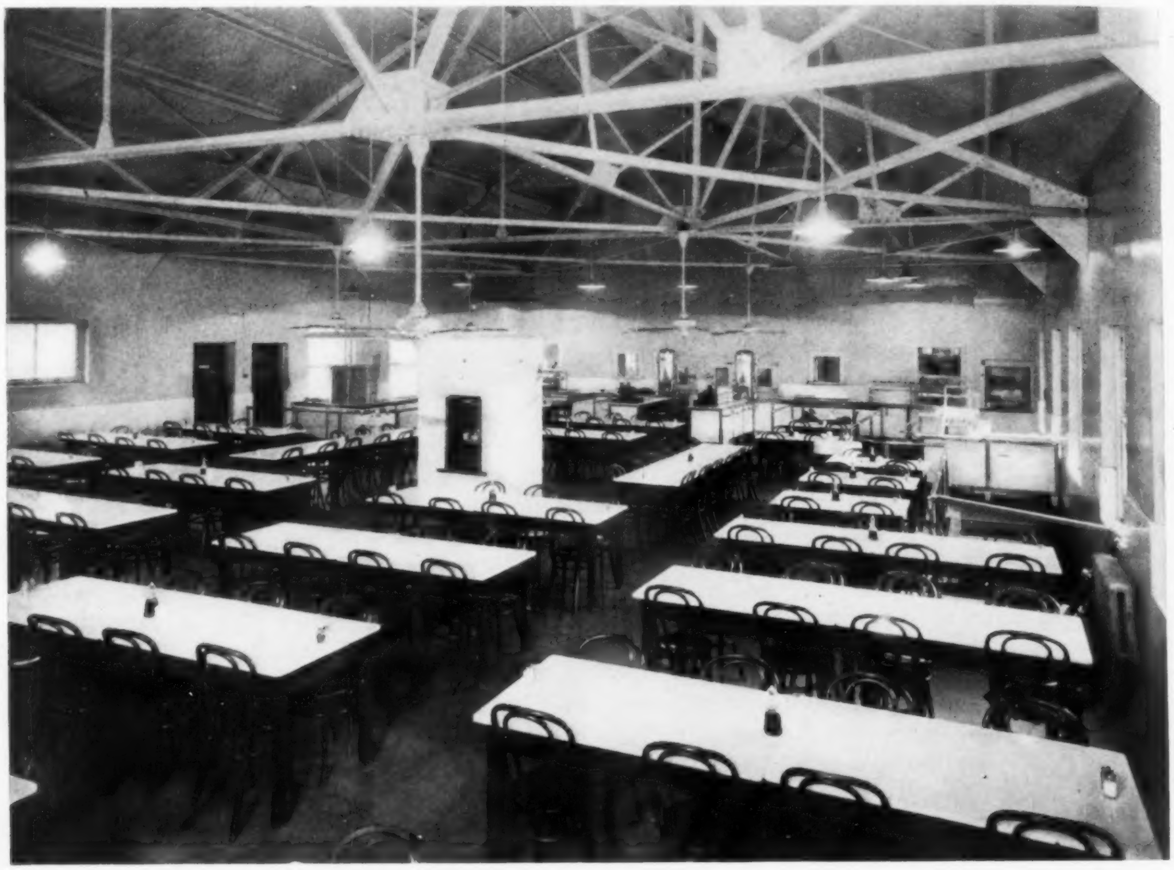
IF, as is usually the case in modern industrial buildings, a cafeteria is to be included for the benefit of employes, this feature should be given careful and practical attention in the architectural plans, or its operation will suffer, and its outfitting cost will quite likely be affected as well. The actual planning of the food service facilities should, of course, be placed in the hands of trained kitchen engineers such as are connected with the leading outfitting concerns, but in order that they may have a satisfactory basis upon which to work, it is imperative that the size, character and location of the dining room and kitchen space should be determined in accordance with a few well defined principles.

Calculating the number of meals to be served is at best only an estimate in any individual case, so that general percentage figures are used only as a means of comparison. The proportion of employes who will be likely to patronize the cafeteria will depend upon: (a) the type of employes, particularly whether they as a class will be likely to eat in a restaurant at all; (b) the location of the plant with reference to the employes' homes; (c) the existence of outside restaurant facilities within reasonable distance; (d) the attractiveness of the cafeteria and of the food served. These factors should all be borne in mind when it is said that under reasonably favorable circumstances the average experience is that about 60 per cent patronize the cafeteria at the start, and that this may increase gradually to approximately 75 per cent within a year's time if the cafeteria operation is satisfactory. Thus, if a single lunch period is used, a plant with 300 employes would require a cafeteria of 200 or more seats. It might be mentioned that two lunch periods are frequently used, one reason for this being the desire to allow factory and office employes to use the cafeteria at different times. If this is done it will naturally reduce the number of seats in proportion to the total number of employes. Some excess capacity should really be figured upon to take care of future expansion.

Whether single, double or multiple cafeteria service counters should be used is a problem that will have to be solved by the kitchen engineer. Greater serving speed can be obtained in industrial cafeterias than in those catering to the public, due to there being a more limited menu. The maximum for a single counter is about 200 persons served in from 10 to 12 minutes, which is about as long as it is wise to make

Cafeteria of the Edison Electrical Appliance Co., Chicago

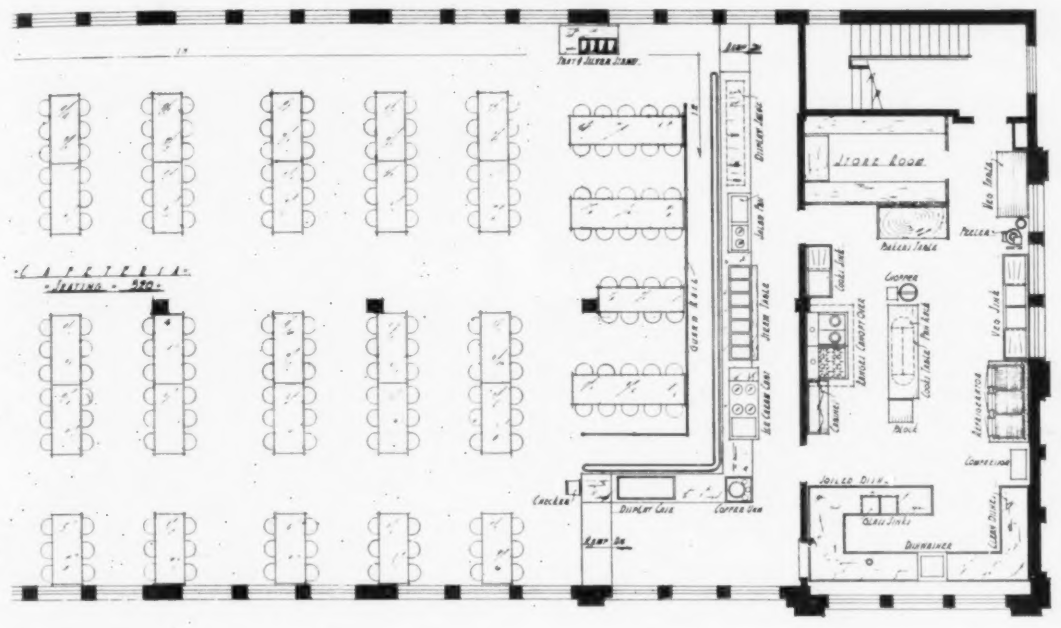


Employes' Cafeteria, Illinois Steel Company, South Chicago

people stand in line. If more than 200 employes are to be fed, therefore, either two lunch periods or double service counters will be necessary. This question, and also the length of the counter, will have a bearing upon space requirements as well as upon room arrangement, and therefore should be settled as soon as possible.

Space Requirements. The accepted method of calculating space is to use an area per seat formula, yet this cannot be taken strictly at its face value, for it will be found that there are several variable factors among which the most important are: the type of seating arrangement (size of tables, amount of aisle space, etc.); the shape of the room, and the resulting amount of waste space; the type of counter layout (whether single, double, or multiple service); and the completeness of the kitchen facilities. Barring any abnormal amount of waste space, this rule may be accepted as a safe normal working formula: For cafeterias of medium size (120 seats and up) the area of the dining room, including the cafeteria counter, should be 15 square feet per seat. While there have been cafeterias in which this figure is reduced to as low as 12½ or 13 square feet per seat, this does not allow a comfortable amount of space at tables and makes it necessary to use large seating units which may be satisfactory for high school pupils, for instance, but which is undesirable for adults. In the interest of comfort and the elimination of crowding and confusion, therefore, it is wise to adhere to the 15 square feet per seat rule. The cafeteria kitchen should occupy a room from 25 to 33 1/3 per cent as large as the dining room and service area, adding about 5 square feet per seat and making a total for the kitchen and dining room of 20 square feet per seat.

On this basis a 200-seat cafeteria would need a total area of 4,000 square feet, of which 1,000 square feet would be occupied by the kitchen, 500 square feet for the serving counter, etc., and 2,500 square feet for the dining room proper. It should be mentioned that in a very small cafeteria the space per seat would have to be larger than the figures given here. For example, a 32-seat lunch room such as is used in some industrial buildings, notably in telephone exchanges, would need about 720 square feet of space or an area of 22½ square feet per seat. The minimum area for a kitchen, regardless of the size of the restaurant, is from 300 to 350 square feet.



Plan of the Kitchen and a Portion of the Cafeteria of the American Can Co., Chicago

Location in the Building Plan. The first requirement is good light and air and pleasant surroundings, for the factory lunch room will be poorly patronized and thus fail to serve its purpose if these are not had. The second is to locate the cafeteria in such a way as to make it accessible to employes of all classes without making them travel unnecessary distances, and without causing confusion and congestion in corridors or other passageways. One of the best schemes has been to group all of the employe accommodations, such as washrooms, locker rooms, smoking or card rooms, etc., together with the cafeteria on the ground floor, close to the entrance of the building. This is logical and convenient in every way. It also agrees with the general advisability of placing the cafeteria near the building's entrance which, among other things, makes it accessible to the employes of neighboring plants, if such outside patronage should be desired. There is no objection from the standpoint of operation to an upper floor location for the cafeteria, although if this is done the matter of incoming supplies, garbage disposal, etc., needs rather careful attention and requires easy access to a good sized service elevator located within convenient reach of the service entrance to the building.

It is of the greatest importance to locate the kitchen immediately adjacent to the cafeteria, for otherwise its smooth operation will be severely impaired. The best practice is to have the kitchen extend along one side of the cafeteria room, with the serving counter directly in front of it and with suitable openings or passages between the two for bringing replenishments to the counter. Where absolutely necessary, the kitchen may be located on the floor below, but this requires unusual precautions in order to make service practical, and it usually involves expense of installing dumbwaiters or conveyors.

Room Arrangement. The dining room itself should be rectangular, and while not necessarily square, it should not be more than about two times as long as wide. Irregularities in the shape of the room should be avoided as far as possible, especially if they interfere with the use of a straight counter, for although L- and U-shaped counters are practical, they are more expensive to build than straight counters. The ideal kitchen also is rectangular and about one and one half times as long as it is wide. In very small restaurants the kitchen, cafeteria counter and tables are all installed in one open room, but this is not desirable, for it is almost impossible, under these circumstances, to handle the ventilating problem, to say nothing of the unsightliness which results. Large size cafeteria kitchens often should be divided into two or more rooms in order to segregate the store room,

Employes' Cafeteria in the Montgomery Ward & Co. Building, Fort Worth

dishwashing department or other subdivisions from the main kitchen. Whether or not this is likely to be necessary will develop as the actual equipment engineering plans are being prepared.

Auxiliary Requirements. Adequate provision for hot and cold water, steam, gas, power, sanitation, drainage and ventilation unfortunately cannot be handled by means of any known set of general formulæ,—and yet, unless they are handled with accuracy, they are likely to prove troublesome. For this reason it will be advisable to call in the cafeteria specialist at as early a time as possible in order that all such technical matters may be settled before the building plans have progressed far enough to allow any complications to arise.

Counter Construction. Cafeteria counters should be built of metal; wooden counters are unsanitary and impractical. Inexpensive metal counters have an angle iron framework with galvanized steel panels which may be suitably painted, while better grades have porcelain enameled steel, glass, or Monel metal panels. While glass counter tops are popular, the present trend is toward the use of polished Monel metal, as this eliminates breakage and is equally sanitary. Table tops of linoleum, rubber tile, composition or ¾-inch glass are all satisfactory, but wood is not. There is a type of table especially designed for industrial use which has a pipe-leg base with stools attached, and this has practical points in its favor, although it is not very likely to appeal to high class employes.

Specifications and Bids. It is well to offer a word of caution about cafeteria equipment specifications. When one manufacturer bids on another's specifications, he is really figuring his method of construction against the original, and there is frequently a world of difference between the two. This may be unavoidable, but its danger will be minimized if the architect will insist upon very explicit specifications in the first place, and upon an equally clear definition of variations in either construction or materials from additional bidders. Especial attention should be paid to the kinds and gauges of metal used, as this is one of the most common points of variation. The lack of standardization among equipment manufacturers makes these precautions essential if the contract is to be awarded on a fair basis.

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PLUMBING AND SANITATION OF INDUSTRIAL BUILDINGS

BY
A. R. McGONEGAL
SANITARY ENGINEER

DESIGNING the plumbing equipment for factories, mills, warehouses and industrial buildings and plants or groups of buildings requires almost as varied treatments as there are purposes for which the plants are built. This variation persists in every study made. Not only does the proportionate number of fixtures vary, but the type as well; and the materials to be used, both rough and finishing, must be made applicable to the particular use. In hotels, apartments, office buildings, schools and similar structures, there is a known ratio of the number of fixtures per room, per unit of area or space, or other fixed measurement; and even the types of fixtures are of well recognized standards, whereas every industrial building or plant seems to present a different basis of design.

Modern warehouses have great floor areas and have few employes to be provided for. Steel works, shipyards, car and locomotive shops, potteries, paper mills, and similar plants cover large areas, frequently with many buildings, and have but few more employes per unit of area than the warehouse, though they are widely scattered and the several groups of employes are "settled" in their particular parts of the plant, instead of laboring in one section for a time and then moving to another as in warehousing. On the other hand, clothing factories are heavily peopled per unit of area.

Fixture Ratio. In industrial work the ratio of fixtures must be based on the number of employes, but in the case of few employes and large areas this ratio should be modified by the time factor. While it is true that in modern manufacturing practice, piece work is the rule and time out is the employes' time, still it is poor organization practice to require an employe to go great distances for toilet purposes, and in group assembly work it is out of the question.

The toilet fixture ratio established in the factory laws of many states,—one water closet to each 15 employes,—appears to be well justified in practice if modified by the individual conditions presented. For instance, in small plants the ratio might better be 1 to 12. Two urinal fixtures are generally accepted in lieu of one water closet, provided half the legal number of water closets are furnished and urinals substituted for the others. The proper installation and economical maintenance of plumbing fixture equipment require that fixtures shall be grouped and not scattered, and while nothing is gained by having more fixtures than are necessary for the number of people to be served, a toilet room containing fewer than six water closets and eight or ten urinal fixtures will be generally found unsatisfactory. It is good practice, too, to figure one more closet and one or two more urinals in each toilet room than the numerical ratio indicates, to take care of fixtures out of use, unusual demand, and similar conditions. Sometimes an extra closet enclosure is provided with a lock for the foremen, but it is generally considered better to provide a separate private room for them. Small wash sinks or lavatories should be in each toilet room for reasons of personal cleanliness, these being in addition to the regular wash-up facilities provided elsewhere. Bearing in mind that employes should not be required to go long distances, clothing factories and similar well peopled factories in loft buildings should have at least one room for each sex (if both are employed) on each floor, and if the number of employes exceeds 200, two toilet rooms are better. In specially built factories of the long and narrow type two toilet rooms staggered on opposite sides, each one quarter the way from the end, will be good design. In steel mills or in other places where men are more scattered, separate toilet buildings are to be preferred; perhaps one to each fairly large building or group of small structures will be found best, but the time element should be considered. The writer has seen single industrial buildings of such length as to justify two or even three toilet locations.

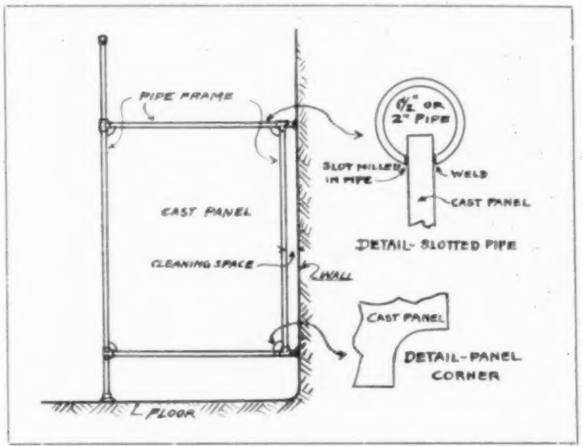
Wall, Floor and Partition Materials. Naturally, in industrial work, great care should be taken in wall, floor and partition work to make it of the most substantial and lasting character, and of materials easily cleaned and kept clean. It is a demonstrated fact that employes will not have the urge to disfigure or damage fixtures or fittings in a substantial, well lighted, and well kept toilet room. Sunlight is not only one of the chief germicidal agents but is a cleanliness aid without peer. Every toilet room should have more than ample window area opening out into a space open from ground to sky and far enough removed from any walls or buildings opposite to assure direct sunlight to all the windows for half the day.

In selecting material for wall and floor finish, it is proper to couple reasonable cost with desirable qualities. Perhaps the most satisfactory floor surface will be one of the several bituminous mastic floors laid as a unit on a concrete subfloor. They are not unduly expensive, are

water- and vermin-proof, wear well, and if need be they can be "ironed over" or can be taken up, remixed and relaid.

For wall work the writer has never seen any material lending itself to this purpose better than the mottled salt glazed hard burned brick to be had in any locality. It can be had in a very light tan, and if laid in a fat cement mortar with thin tooled joints it presents a scratch-proof, pencil-proof, and practically non-absorbent surface. It can be carried to a height of 8 or 9 feet and the upper walls and ceiling finished in white hard plaster for light-reflecting purposes. These bricks can be had with coved bases and rounded for room corners so as to eliminate dirt-retaining angles, and the plastered ceiling can also be rounded to the walls.

The selection of partition materials offers a wide range of choice, but when finished the partition should be very strong, and easily kept clean. All fastenings to wall or floor should be made with heavy toggle, lag or through bolts, exposed faces flush where possible, and concealed nuts upset. If partition work is of metal, welding or brazing should be the rule. In selecting metal partitions of commercial units, they should be judged on their strength, rugged construction and durability because of the rough usage they must stand in industrial plants. A satisfactory closet partition can be made up with a 2-inch steel or iron pipe frame, the pipes slotted to receive a cast or rolled sheet 3/8, 1/2 or even 3/4 inch thick. A rough surface cast panel possesses the advantage of discouraging attempts to write on it, and it is practically unbreakable. The pipe at the front of the frame should be carried up above the partition panel and be connected across the fronts by a transverse pipe high enough to discourage attempts to swing on it. The pipe at the back of the frame should be supported 2 inches away from the wall, leaving the wall



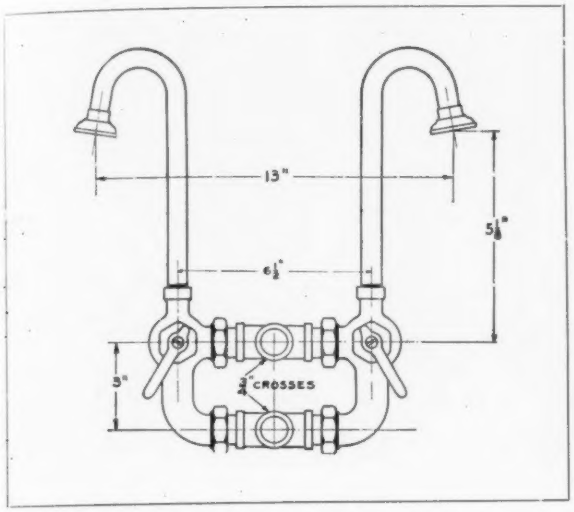
Details of a Pipe and Panel Closet Partition

surface free for cleaning. The fittings with which the pipe frame is put together should be welded or brazed, if indeed the whole pipe frame for the partition work is not welded without fittings. For finish, plain lead and oil in a neutral gray will be found satisfactory. If the partitions extend out far enough to constitute an acceptable screen, there is little need for doors to the closet enclosures, and it is no longer considered necessary or advisable to provide them.

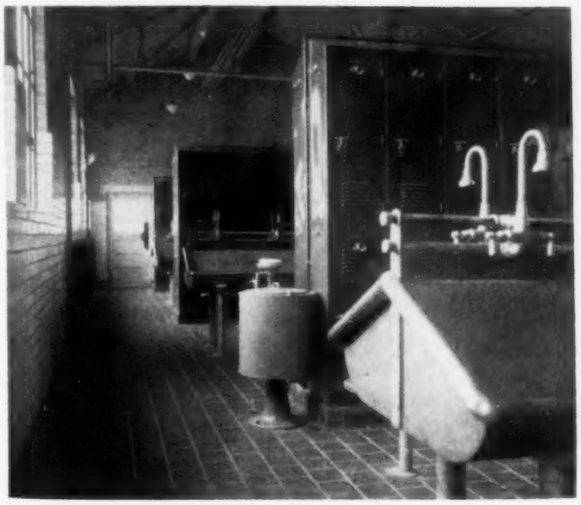
Locker and wash-up rooms have a decided advantage over groups of lockers scattered throughout the plant. It is not so necessary that these facilities be within easy distance of the places of employment, and consequently they can be constructed in larger units. It is not considered good policy to have the lockers in toilet rooms because of odors, the greater moisture content of the air near more or less constantly running water, and other reasons; but it is good practice to have them adjacent to toilet rooms or buildings. Wash-up sinks are in general use at quitting time only, and may well be located in locker rooms if the plan is such as to make such construction desirable.

Lockers are of two general classes,—those with wire mesh or expanded metal fronts which ventilate into the room, and those with closed fronts and ventilated by duct and fan. If ventilated by fan, the air intake should be from the outside or else protected against dust. Many installations are supported from walls or on stands 8 to 12 inches from the floor to permit cleaning under, and the tops should be so sloped as to prevent dust collection or the lodgment of papers or cast-off clothing thrown there. Unit steel lockers come in a wide variety of stock styles and sizes. Double-tier lockers are extensively used, but wider units are necessary than for the single tier, and in cold climates the short locker is hardly suitable for heavy outer garments. A narrower long locker is more satisfactory to the user and makes for contentment of the employe. Locker keys cause endless trouble through loss of keys, leaving keys at home, and wear. Three-number combination knob locks will give an almost endless variation of settings, can be had with almost any make of locker, and will generally be more satisfactory than the keyed locks.

Wash-up sinks can be had in a great variety of styles and in several materials. Slate, soapstone, an especially treated cement, glazed earthenware, and enameled iron are offered by several manufacturers, and they may be had in long, narrow, single or double patterns, individual type lavatories, large circular basins accommodating several around the rim, or long trough-like sinks with individual tipping basins. The class of users, the space available, the shape of



Wash-up Fixtures for Exposed Supply Pipes and Double Sink



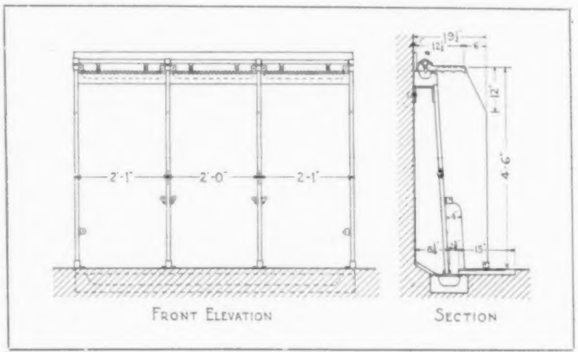
Lockers with Wash-up Sinks Between Centrally Located Drinking Fountain

room and other considerations generally dictate the selection of the particular type and material. If the designer is intent on permanency, perhaps it is better to build the wash-up sinks to fit the requirements. An alloy of metals can be used to form up a wash-up sink to fit any specified conditions. There are a number of instances in industrial plumbing where "Monel" metal wash sinks have been given hard usage over a long period of years and are still intact and untarnished, special handwashing compounds and mechanics' soap notwithstanding. Monel metal is a natural alloy of copper with a high nickel content.

The use of a gooseneck spray supply fixture for wash-up sinks is practically universal. This fixture mixes hot and cold water through a single column in much the same manner as a shower bath fixture; indeed it is identical in design and operation, but on a smaller scale. The usual equipment has hot and cold faucets so that each user can vary the temperature to suit, and as there is no stopper in the sink waste, washing is always in running water. Sometimes knee-action or elbow-action valves are used, but they seem particularly subject to repair costs, and the quick compression hand-operated faucets are more generally used. In cases where the manufacturing process requires volumes of very hot water and the wash sink supply is taken from it, it is well to use a temperature-limiting valve on the line, and more often than not, pressure regulators on both general supply lines will save water and avoid excessive splashing. In some cases a liquid soap distributing system is deemed desirable, but while special mechanics' soap can be had in liquid form most operators prefer their own particular brands, and the trouble required to maintain a soap system can thus be avoided.

Shower baths are frequently provided for workmen, and these are preferably installed in "gangs" with a single pipe feed from a temperature-regulating valve set at a predetermined degree. Such a valve should be provided with a constantly flowing waste to keep the valve "set," but this waste connection can usually be arranged to discharge so that the water can be put to a useful purpose. It is usually considered unnecessary to divide off the showers with partition work; a number of valved heads are grouped in a suitable room with one or two large drains in the floor.

The urinal fixtures may be either the well known earthenware stall type or constant-flush slate fixtures. If of earthenware, the vitreous ware fixture is more permanent and sanitary than the glazed biscuit porcelain on account of its resistance to crazing. At the present time it cannot be obtained wider than 18 inches, but they can be set in battery with three to six intervals. The constant-flush slate fixture consists of especially non-absorbent slate waste trough,

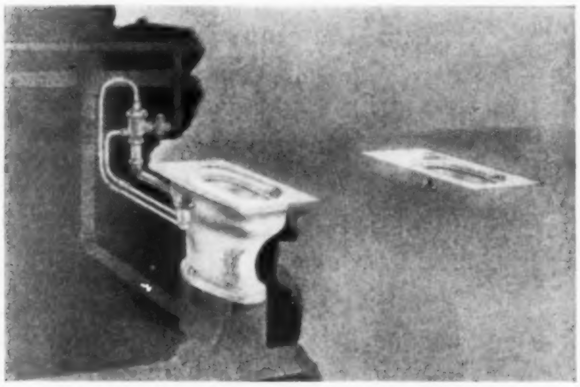


A Continuous Overflow Flush Slate Stall Urinal

backs, wing slabs and a flushing trough with serrated edges distributing a constant and even thin film of water over the whole width of the fixture. These slate slabs are built into a unit fixture of as many stalls as may be desired and are standard with either 21- or 24-inch divisions. On account of the exceeding thinness of the water film when properly adjusted, the water consumption will not be unduly great and will probably compare favorably with that of the stall type with hand-operated valves. Whichever type is used, the waste should be set in the floor so the floor will drain into it. No trap under a urinal fixture should be less than a 3-inch to prevent stoppages.

To the selection of water closet fixtures the engineer should give most careful consideration. Some plants employing foreigners have found it necessary to have part of the equipment in "squat closets." The fixture is practically the same as the regular type except that the water surface is farther back in the bowl, and the rim surface is formed into a floor slab. Some doctors claim that this type of fixture should be be used to the exclusion of the generally accepted standard height of from 15 to 16 inches. It is their theory that a squatting posture promotes proper physical action and that the comfortable chair-like bowl interferes with it. Certain it is that the subject has received much thought, for only a few years ago the low bowl had some vogue, and today one prominent maker is forming the rim of his best selling bowl to fit a theoretically proper position. Many of our schools and institutions use the juvenile height of 13 inches, and wall hung closets are frequently set at this height.

Wall closets, if used, should be of the blow-out type and not the siphon action, but they must have flush valve operation and a strong pressure, certainly of not less than 50 pounds. They should be supported from a cast iron "chair" embedded



Squat Type Closets Operated by Floor-push Flush-valves

Squat Type Closets of Syphon Jet Pattern, at Left of a Wall Type Closet

in the wall and concrete floor and not supported by the soil pipe with a yoke. For industrial work the writer's preference is for the 15-inch height standard siphon jet bowl specified by the Federal Specification Board, except that the siphon limb should be enlarged to pass a 2½-inch ball. This extra large waterway is insurance against constantly obstructed closet bowls with attendant annoyance and cost of taking up to clear. The added cost of this enlargement would be more than offset by the cost of disconnecting and resetting for a single stoppage. If these special bowls are ordered, the inspector should see that the stock bowls are not substituted, by passing a 2½-inch wooden ball through each one before permitting its setting and connection. In addition to demonstrating that the specified waterway is furnished, it shows that there is no interior obstruction such as drips or clots of glaze fired on the ware to become catch-alls in service.

The method of flushing will depend on available pressure, pipe sizes and other considerations. The practice has become very general to make a complete flushometer installation, but the use of tanks is coming back into favor. With high grade fittings few or no repairs are needed except a single ball cock washer and a new tank ball every two or three years, and it is a simple matter to shut off the valve on the supply and replace them. The average flushvalve rarely goes longer than that without needing attention, and the repair of any one of the several best on the market is a rather complicated matter of several washers and packings. Even the diaphragm type which seems to be the simplest has two or three washers and a diaphragm. The greatest trouble with the tank seems to be the tendency of some workmen to take the cover off and store bootleg and other supplies in the tank, or to use it as a repository

for empty bottles, cast-off underwear and the like. This can be checkmated by fastening the cover down so that it requires a special tool to remove it. The better grade of vitreous tank is practically everlasting. Whether tanks or flush-valves are used, a careful selection should be made and adhered to so that it will not be necessary to carry repair parts for several different makes. This also applies in the case of shower valves, sink faucets, and plumbing valves generally. Parts should be interchangeable so far as possible, and a single line of repairs should cover all needs. High grade rubber-covered composition seats are water- steam- and vermin-proof. The hinges should be of cast metal and should be rustproofed by the Bower-Barff process or chromium plated to give a non-corrosive finish.

Sinks. For general wash-up purposes floor sinks are generally preferable to slop sinks in industrial work. Mechanical floor scrubbers are used on large floors, and they can be wheeled over a floor sink and washed out and, in any service, a floor sink will do all that a regular slop sink will and be handier. Floor sinks are set down on the floor construction with the rim flush with the surface so that they act as floor drains. If it should be found necessary to use floor drains elsewhere about buildings for dry manufacturing, care should be taken that there will always be enough water to keep them sealed. Of course, in certain lines of manufacture floor drains are necessary to take care of excess liquid waste and splashings, but in such cases the permanency of trap seal is assured.

So simple a matter as the location and service of drinking fountains has a great bearing on one of the vital points in plant operation,—labor turnover. Proper and satisfactory plant operation requires that the several employes' stations be occupied daily by those familiar with their duties. Constant change of personnel, even temporarily, or temporary but recurring indisposition on the part of employes has a tendency to slow down production and sometimes to interfere with even the quality of the output. Laborers require drinking water, and the temperature conditions under which they work, the character of work, the section of the country and the season all have definite bearing on the amount of water needed to maintain the workers' health at par and on the manner in which it should be provided, so it is not possible to plan an installation without these facts as a basis. The subject of drinking water furnished in manufacturing plants has been the subject of much study by medical men working with some of the largest industrial organizations in the country. The almost universal opinion among them is that the lack of care in the item of drinking water causes much layoff on account of stomachic and intestinal disorders, and is a frequent cause of cramps and diarrheal disturbances, upsetting the rhythm of work, especially where employes work on a traveling assembly or where work of gangs under high temperatures is the rule.

The human skin is an important factor in elimination and in keeping the worker's body fit. The skin cannot do its duty unless supplied with moisture. Employes engaged in light manufacturing in cool rooms do not drink as much as heavy workers or those working in high temperatures. The workmen should and will drink from about a minimum of three pints to over a gallon a day, depending on conditions. The amount to be furnished should be about twice the amount of the use estimated. The consumption will be less when light work is done in moist, cool surroundings without moving about much. Dryness, heat, moving about and heavier work will increase the amount.

Two considerations are important. The drinking fountains must be generous in number so that no employe need go far to quench his normal thirst. Unnecessary distance tends to make for fewer drinks, and each drink of more water than necessary, sometimes even of harmful amounts, whereas if fountains are clean and inviting and handy it results in many small drinks that don't tend to waterlog the intestinal tracts and induce sluggishness. The second consideration is the temperature of the water served. Ice cold water, especially ice water, if taken while the body is heated, has a tendency to produce cramps and the following intestinal disturbances, and under certain conditions this may stop body perspiration and induce "colds." Continual recurrence of this condition may have a definite and permanent effect on health. On the other hand, employes will not drink water so warm as to be unpalatable, and their health and effectiveness suffer from a lack of moisture. The consensus of medical opinion, as expressed by those working directly in industrial plants, is that a temperature at the mouthpiece of about 50° Fahr. should be maintained. This temperature makes some artificial cooling necessary. No natural ice cooling arrangement can function satisfactorily. If the cooling is handled at a central unit and the water pumped through circulating lines, the connected unit should be small enough so the water would leave the pump not lower than 47° and be not warmer than 53° at the return. It is probably better to have individual cooling units which can be maintained at a definite pre-determined temperature. There are a large number of manufacturers of these refrigerating units, and there is almost infinite variety to select from. Care should be

taken, however, that the selected unit is so constructed that the cooling element itself containing the refrigerant in either gaseous or liquid form is not immersed in or in direct contact with the drinking water, as the gas might escape through a minute leak and contaminate the water. For instance, sulphur-dioxide gas escaping into the water would form sulphurous acid, which is good for neither man nor pipe on account of its corrosive action.

As to the fixture itself, the diagonal stream is generally considered the most sanitary, and probably the dual stream gives the best shaped bubble for drinking. It should be adjusted to the point where the "bubble" gives a sufficient amount for a satisfying drink without the drinker feeling an urge to follow the stream down with his lips, to contaminate or be contaminated by the nozzle.

The water supply and sewerage planning for a manufacturing establishment is not necessarily complicated, but the layout varies with every different line of manufacture and with the local conditions present. Paper mills use vast quantities of water, soil it in the process, and then must get rid of it. Certain types of reduction plants and steam power plants are also heavy water users, as are cloth finishing works and large laundries. On the other hand, garment factories, cloth print shops, and similar businesses use little water, and a multitude of other industrials vary between the extremes.

Cross Connections. The provision of quantities of water for manufacturing purposes lies outside the plumbing field and is taken care of in plant installation, but certain precautions must be taken against contamination of the water supply for purely human use such as drinking, washing, and sometimes cooking, and it is quite within the province of the plumbing designer to see that there is no opportunity for cross connection between the two uses or between the pure water supply source and the source of water used in plant operation, if they be different. It is not enough that there be a checkvalve between the two, because unfortunately checkvalves do not always work, and even when they do, a single deadly bacterium can pass through the tightest checkvalve ever made during a temporary unfavorable difference in pressure, and populate the entire domestic supply in a few hours. The same thing can happen if the system is designed with an emergency gate valve between the two systems. A complete contamination does not always require that the valve be carelessly left open.

The only definite and positive preventive of cross connection is a complete separation with an "airbreak" between. This can be accomplished by setting up an emergency supply for the industrial needs by discharging the potable water through a balanced ball cock over an open surge tank and pumping from the tank into the industrial line. This pumpage power can be taken from the supply itself. In the days before city water treatment became general, it was quite a customary thing to use the city supply of hard water and to install in each building a duplex pump powered by hard water to pump a soft water supply from a cistern. If the normal city pressure is greater than the industrial supply pressure, there will be no water wastage in the duplex pumping process, but if they be the same or the industrial pressure greater, then there will be an overflow wastage which, however, will usually involve less cost on excess water charge than the cost of current and maintenance of an electric pump. Sometimes this small wastage can be led to storage tanks for boiler feed or other purposes. With these duplex water pumps, an entirely automatic arrangement can be made, the relative areas of the pistons and proper valves being all that is necessary, whereas an electrically-driven unit arranged for automatic service would need pressure-control valves, contactors, starters and similar apparatus to keep in repair.

There are innumerable cases where epidemics of disease have been definitely traced to careless or inefficient cross connections in industrial plants. The threat of reduction of pressure on the clean water side is always present. This is especially true with city water pressure, which is likely to drop appreciably during daily peak consumption in homes. Mains sometimes break or a joint blows out and cuts down the pressure, or there may be a bad fire and the fire department pumpers "bleed" the main. In any of these cases, instead of the supply flowing *to* and *into* the plant's system, it flows *from* the system out into the mains. Any purposedly or carelessly opened valve on the supply to a mixer, vat or other apparatus, instead of filling it simply empties its contents out into the clean water mains of the plant and the city. On return to normal this contaminated water can be drawn at the kitchen sinks in the neighborhood of the plant or even at the drinking fountains in the plant itself, and the owners of the establishment are both morally and legally responsible.

In one case on record, hides were soaking in a vat, and the attendant desiring more water opened the supply valve during a bad fire and the soaking liquid was immediately sucked out into the city mains, creating in the weeks that followed a scourge of anthrax. Scores of serious cases and many deaths were reported. A typhoid epidemic with several fatalities followed a similar opening of a valve in a steam power plant cross

connection between the city supply and a condenser supply from a polluted river. An unusual but extremely serious case with many deaths occurred when a hose from a clean water supply was put in a vat of chemicals (one of which was arsenic) and the attendant, after going to another part of the building to turn the water on, returned to find the chemical vat empty. There are scores of such cases on record, and the only sure remedy is a positive air break between the city supply and the industrial supply, and in the plant itself an air break between the industrial supply and the supply to drinking fountains, lavatories, wash-up sinks, showers and similar fixtures. If thought necessary, excess industrial water may be used to flush closets and urinals, but there is the ever-present possibility that an ignorant workman may cut in a cross connection when putting in a new fixture or making repairs and extensions. The definite air break can be had in several ways: by a duplex pump or a power pump drawing from an open surge tank; by the city supply feeding a roof tank when only low pressures are needed in industrial lines; or with vertical loops some 40 feet high with an automatic air relief valve set at a pre-determined release pressure.

Pipe corrosion is serious enough to warrant very careful planning. Corrosion or rusting of water supply pipe not only reduces its capacity progressively during the process but ultimately makes necessary its replacement, and it is a prolific source of repair annoyance and costs. High grade brass pipe (80 per cent or more copper) is of course a very great protection against corrosion, but in large plants the pipe cost would be prohibitive, and it is cheaper to provide deactivators to remove the oxygen by passing through beds of steel or iron scrap or by automatically adding an alkaline solution. Chlorine and alum, frequently used to assist in clarifying during settling or filtration, only make water more corrosive by gleaning out the turbid elements which tend to protect the pipe. The alkaline solution, usually lime, is added after settling. The larger cities of the country are now treating their municipal water supplies to reduce the rate of corrosion, and some of them have been very successful; but it will be many years before such treatment is universally applied, and in the interim, the architects and engineers for industrial buildings and plants must ascertain whether the city supply under consideration is so treated, and if not, must plan their own treatment. Up to a few short years ago little was known about pipe corrosion, but several separate studies have been and are still being made by the different metal trades bodies, and by various government agencies, and enough definite knowledge is now in hand to indicate that it can be controlled up to certain limits. We can measure the rust-forming water conditions from day to day, or hourly if need be, through the use of a common indicating solution that can be handled by an ordinary laborer, and adjust our alkalinity accordingly.

Pipe. As to material for our water piping system, if high grade brass is beyond our budget, cast iron pipe will unquestionably give the longest and most satisfactory service, and should always be used when underground or in contact with concrete. Unfortunately, cast iron pressure pipe cannot be had in the smaller sizes used in general plumbing connections, and we must use either galvanized wrought iron or galvanized steel. Screw pipe wherever practicable should be exposed for inspection and painting so as to reduce outside corrosion. Many experiments have been made for ascertaining relative life of wrought iron and steel pipe. The results seem to show that while corrosion covers greater areas in the steel pipe, the pitting is deeper in the wrought iron. Pipe makers believe that the effective removal of the mill scale can be accomplished and that it will reduce pitting. However, the evidence points to a usually longer life for the wrought iron pipe. The cost of installation is the same.

The sewerage of industrial buildings or plants more often than not calls for earnest study. In some manufacturing lines great quantities of waste must be handled. In others trade wastes, sometimes offensive and even poisonous, must be neutralized, at least partially, and still others carry great proportions of solid matter in suspension. The day is passing when we may dump our unusual waste indiscriminately into city sewers, into nearby rivers, or spue it out on the land to rot and spread a stench over the countryside. States have river pollution laws, cities that are forced to maintain sewage treatment works are jealous of their sewer systems, and the county health official is abroad in the land.

If the sewage is to be discharged into the city sewerage system, or if it is to be treated in a septic tank before discharging it into a nearby stream, it must approximate domestic sewage in composition and contain only such putrescible matter as can be reduced by the plant to which it is bound, all other matter being removed or neutralized by special treatment. Heavy matter in suspension can be removed by suitable rotating screens, and the screenings can be de-hydrated and baled. Other suspended solids and colloidal matter can be removed in settling or sludging tanks, and the effluent chemically neutralized. If the plant is large enough to justify attendance, the sludging process can be of the activated type

and sufficiently complete to justify omission of the septic tank and the use of a timed contact bed on the effluent. The de-hydrated sludge resulting from this process can be bagged and sold, possibly for enough to pay the cost of the operation. The Milwaukee sewage works cannot furnish enough bagged sludge to satisfy their market, and this condition is general wherever such systems are in use.

The design of the sewerage system itself is of course dictated by the size of building or plant and the processes used. If the plant is very large, consisting of many scattered buildings on a level tract, it may be found advantageous to keep the sewers closer to the ground surface than would be possible if a normal and necessary grade is given to the sewer lines. This can be accomplished by dividing the tract of land into areas, discharging the sewage of each area into a manhole limited in depth to 7 or 8 feet, and installing in it an air- or steam-operated automatic lift to raise the sewage to near the surface, from whence it will flow by gravity to the next manhole, repeating the process from manhole to manhole.

Under no circumstances should the fall of the sewer be unduly flat, especially if sewage has much matter in suspension. The use of automatic sewer flushing basins is sometimes necessary on the dead end of a sewer, but they should never be used on the assumption that when used they permit flatter grades. The necessary sewer grades are dependent on several factors, but a general average velocity of flow of about 4 feet per second, at least in the smaller sizes, must be maintained to make a sewer self-scouring. Small sewers must have more grade than large to maintain an even velocity. In the absence of accurate computation to a theoretical finding, there is a "rule of thumb" rule that is accurate enough for all practical purposes,—"provide one foot fall in each 10 feet times the number of inches diameter,"—one in 40 for 4-inch, one in 60 for 6-inch, one in 80 for 8-inch, and so on. But it is also well to consider that increasing the fall increases capacity and reduces sizes, and for that reason alone, a number of short, well graded sewers with manholes and lifts intervening, make for a small, well scoured and easily accessible main line, whereas a long flat graded sewer must be larger and subject to stoppage, and the far end may be very deep and inaccessible for cleaning, repairs, connections or extensions. Roughly speaking, doubling the fall will increase the capacity some 40 per cent or more, and a correspondingly smaller sewer can be used.

If securing a permanent and trouble-free sewer system is the sole consideration, extra heavy cast iron pipe with calked lead or iron cement joints will be selected for the sanitary lines, and unless there are acids and corrosive chemicals to be handled, cast iron should be considered for the industrial waste. With its lead lock joints, modern cast iron pipe makes a straight, smooth, even sewer without leakage, and strong enough to prevent settlement or displacement. If acid wastes inimical to metal surfaces are to be carried, it may be necessary to use hard burned tile pipe, but if used it should be laid with hot poured bituminous cement joints, on a continuous bed of steel reinforced concrete, and with all joints completely enveloped in cement mortar. Needless to say, this construction approximates the cast iron sewer in cost, but reinforcing and concrete are necessary to protect it and keep it in alignment and put it on a service par with the cast iron construction. With strong acid wastes, silicate iron special acid-resisting pipe may be required, but it is necessarily expensive, and whether to use it or not will be indicated by the concentration and temperature of the waste handled. Suggestions for the use of concrete tile pipe are often made, but so far concrete tile reasonably proof against bottom erosion and top disintegration due to gases in sewage has not been placed on the market. Some lengths may stand the test, but the texture varies, even from the same lot and no line is better than its weakest piece of pipe.

For the soil and vent pipe above ground and the vertical industrial wastes and the rainleaders, the most economical and lasting construction again favors extra heavy cast iron. Wrought iron or steel screw pipe might be favored by a contractor for reasons of his own, and it is very often used in hotel, apartment house and similar building work where there is objection to the hubs of the cast iron pipe coming in the story height, but in industrial work this consideration is non-existent, and permanency is the aim. The rough plumbing should follow the accepted "Hoover Code" construction, with all fixture traps vented by stack or separate vent lines unless the local regulations provide for more complete venting.